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MACHINERY

THE INDUSTRIAL PRESS Publishers, 140-148 LAFAYETTE ST., NEW YORK

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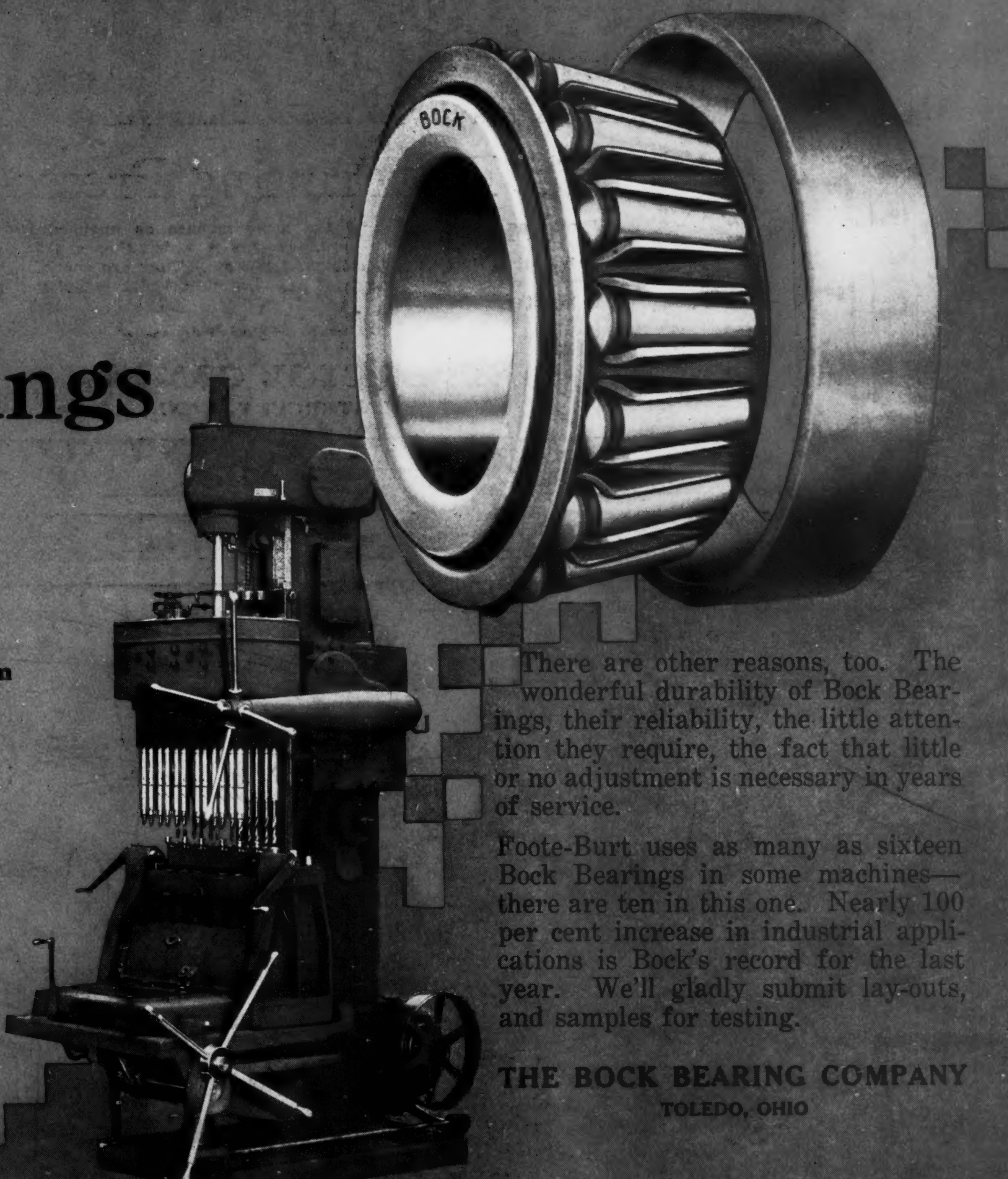

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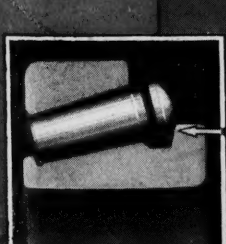

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VOLUME 29

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One of the articles of unusual interest in August MACHINERY describes the application of an ingenious device that makes it possible to study the action of mechanisms operating at a high rate of speed.

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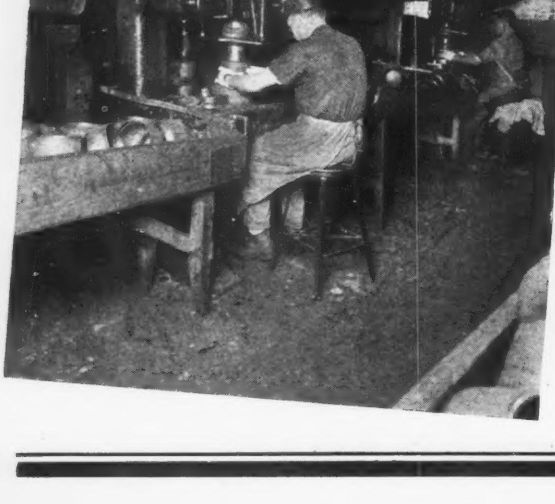
MACHINERY'S Mid-Sum

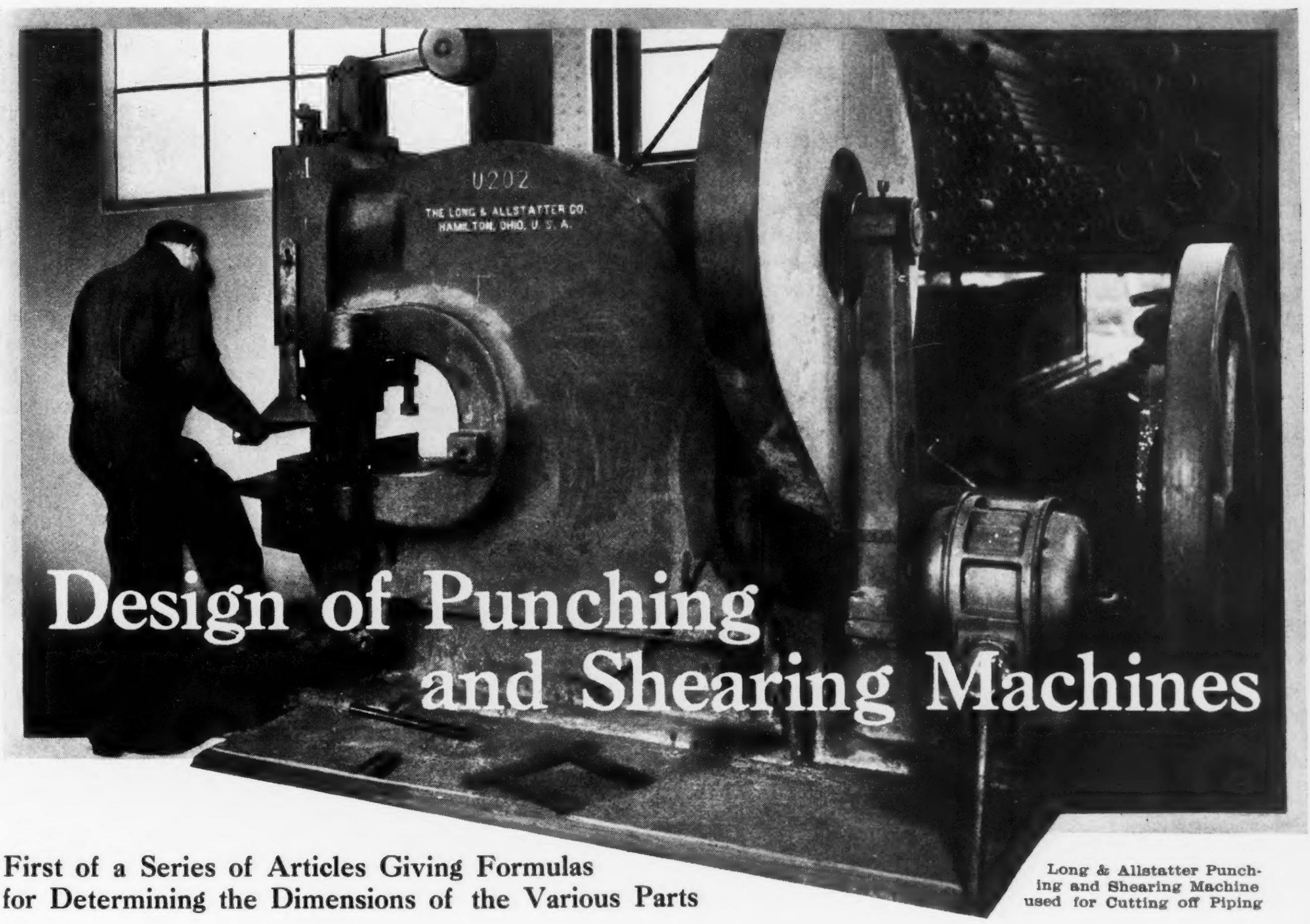


No lack of variety and interest in the articles MACHINERY offers in the mid-summer numbers—July and August.

You can't afford to miss reading these two numbers any more than you can afford to neglect November and December. Turn on your fan if the weather is hot, or take the paper out of doors, for you'll want to know how far we've gone with Prof. Jenkins' articles on The Design of Punching and Shearing Machinery—a series that begins in July. The substitution of steel stampings for castings may mean a lot to a lot of manufacturers—read "Replacing Castings with Stampings." And with the need for bright young men in our shops and factories so urgent, that story of the Co-operative Education scheme so successfully carried on in Springfield, Vermont holds something tangible for the future.

We are just touching the high spots for July—there is a great deal more to read and ponder—and then, there's August.

MACHINERY



Design of Punching and Shearing Machines

First of a Series of Articles Giving Formulas for Determining the Dimensions of the Various Parts

Long & Allstatter Punching and Shearing Machine used for Cutting off Piping

By A. LEWIS JENKINS, Professor of Mechanical Engineering, University ot Cincinnati

THAT the punching and shearing machine offers exceptionally good problems for students in machine design has been recognized by the instructors in this subject of many leading universities. It offers practical exercises in the design of bolts, keys, screws, gibs, bearings, gears, shafts, flywheels, pulleys, belts, clutches, springs, counterweights, and link work, and in the analysis of stresses in curved cast frames. Furthermore, unlike the lathe or most other machine tools the problems met with in designing the various elements are not duplicated. Hence, the design of a punching and shearing machine may be said to consist essentially of a series of problems on the design of the most commonly used machine elements, all of which are combined in the end to form a complete machine

The subject matter of this series of articles is based on the proportions of punching and shearing machines actually built. Much of the material consists of empirical formulas derived from data taken from practically every make of machine built in this country. The necessary information was obtained from experimental data, by actually measuring machines in operation, and directly from manufacturers. Many proportions previously obtained empirically have been put on a rational basis by introducing proper constants in equations, while empirical formulas have been derived for many proportions that do not permit of rational analyses.

The action of a punch or shear produces complicated stresses in the material operated upon. The pressure of the punch and the reaction of the die against the plate produce a shear stress, a compressive stress, and, if there is clearance between the punch and die, tensile and compressive stresses which result from the tendency of the plate to bend. The presence of the compressive and bending stresses renders it practically impossible to determine accurately the shearing strength of any material by means of the ordinary apparatus used in making shear tests. Perhaps a better name for the action of a punch or shear would be "cutting"; this would be indefinite in terms of the concurring stresses.

When the punch comes in contact with the material, the point enters for some distance, and there is a flow of metal into the surrounding portion, increasing the thickness of the metal around the hole. This flowing action continues until the material is stressed, principally by shear, sufficiently to produce rupture. A load-depression curve drawn by an autographic recorder will be similar to the load-strain curve for a specimen under tension in a testing machine. It will be an approximately straight line until the material begins to fail and will then curve downward.

The distance that the punch enters the material before failure begins is called the "depth of penetration," and varies with the thickness of the plate, the cutting angles of the die and punch (angle of the knife in a shear) and the material. The depth of penetration for soft steel, according to Kent, may be found by the following formulas:

For a flat knife,

$$p = 0.3t$$

For a 4-degree beveled knife,

$$p = 0.25t$$

For an 8-degree beveled knife,

$$p = 0.16\sqrt{t^3},$$

in which p = depth of penetration, and t = thickness of plate, in inches. Experiments on mild steel have shown that the depth of penetration may be determined by the following formula:

$$p = \frac{0.35t}{t + 0.4}$$

The depth of penetration is less with hard than with soft materials. However, ordinary structural steel breaks when this point is reached, and is easily forced through, whereas soft steel or iron offers considerable resistance after the depth of penetration has been reached.

Force Required to Punch Holes and Cut Plates

The cutting resistance of various grades of structural steel, soft iron, boiler and steel plate varies from 40,000 to 60,000 pounds per square inch. In designing punching and shearing machines, a value of from 55,000 to 60,000 pounds per square inch is generally used. It is safer to use the maximum value, and all formulas in this series of articles are based on that value. The area of metal cut in punching a hole equals the circumference of the hole times the thickness of the plate. Since the force W, in pounds, required to punch a hole equals the area cut multiplied by the cutting resistance,

$$W = 3.1416 \times d \times t \times 60{,}000 = 188{,}500dt$$

in which d = diameter of hole and t = thickness of plate, as before.

From this equation it will be seen that the force required to punch different sized holes in a given material varies as the product of the hole diameter and the thickness of the plate. Assuming that it is desired to find the diameter of the largest hole that can be punched in ¼-inch plate with a machine designed to punch up to ¾-inch holes in ¾-inch plate, we have

$$dt = \frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$$

$$9/16 \div 1/4 = 9/4 = 2.25 \text{ inches}$$

Thus, the same machine could be employed for punching a hole 2¼ inches in diameter through ¼-inch plate.

The force required to shear plates with straight knives inclined at an angle A with each other may be found by the equation

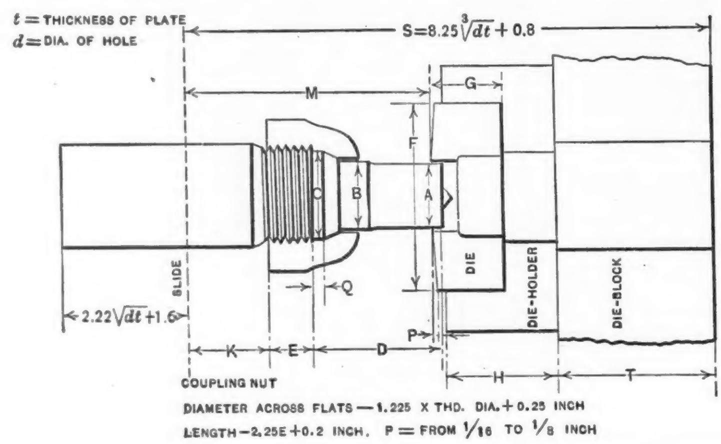
$$W = 0.5t^2 \times \cot A \times 60{,}000$$

An approximate rule for finding the force required to cut metal by punching or shearing is: Force = 80 per cent of the tensile strength of a bar having a cross-sectional area equal to the area of the metal cut. The side thrust on a shearing blade when it is dull and the plate is tipped may be taken as equal to $1.5W$, when W equals the force acting normal to the plate.

Punch Standards

Many different punching and shearing tools are used, the type depending on the class of work and the machine.

TABLE OF PUNCH PROPORTIONS*



No.	A	B	C	D	E	F	G	H	Thread Diam.	Thds. per In.	K	H+D+E	Q
0	5/32 – 13/32	13/32	9/16	1¼	½	1¼	¾	1⅛	11/16	14	5/32	2⅞	5/32
1	9/32 – 9/16	9/16	¾	1½	⅝	1¼	¾	1⅛	⅞	12	3/16	3¼	5/32
2	9/16 – 13/16	13/16	1	1½	11/16	1⅝	⅞	1¼	1⅛	10	3/16	3 7/16	5/32
3	11/16 – 1 1/16	1 1/16	1¼	1⅞	¾	2	1	1¾	1 13/32	10	¼	4⅜	3/16
3S	9/32 – 9/16	13/16	1	1⅞	¾	2	1	1¾	1 13/32	10	¼	4⅜	5/32
4	15/16 – 1 5/16	1 5/16	1½	2¼	¾	2⅞	1⅛	2⅛	1 11/16	10	¼	5⅛	3/16
4S	9/16 – 15/16	1 1/16	1¼	2¼	¾	2⅞	1⅛	2⅛	1 11/16	10	¼	5⅛	3/16
5	1 1/16 – 1 9/16	1 9/16	1⅞	2⅝	⅞	2⅞	1⅛	2⅛	2	10	5/16	5⅝	7/32
5S	15/16 – 1 3/16	1 5/16	1½	2⅝	⅞	2⅞	1⅛	2⅛	2	10	5/16	5⅝	7/32
6	1 3/16 – 1 13/16	1 13/16	2⅛	2⅞	⅞	3⅞	1¼	2¼	2 5/16	10	7/16	6	7/32
7	1 5/16 – 2 1/16	2 1/16	2 7/16	2⅞	15/16	3⅞	1¼	2¼	2⅝	10	½	6 1/16	7/32
8	1 9/16 – 2 9/16	2 9/16	2 13/16	3	15/16	5⅛	1⅜	2⅜	3	10	9/16	6 5/16	¼
9	2 1/16 – 3 1/16	3 1/16	3 5/16	3	1	5⅛	1⅜	2⅜	3½	10	⅝	6⅜	¼
10	2 9/16 – 3 9/16	3 9/16	3⅞	3½	1⅛	6⅜	1½	2½	4	10	¾	7⅛	¼
11	3 1/16 – 4 1/16	4 1/16	4 9/16	3½	1⅛	6⅜	1½	2½	4¾	10	1	7⅛	¼

Machinery

*Dimension K as given in the table is only for plain punching machines; for combined punching and shearing machines, K should be approximately equal to the thread diameter.

The variations are the results of attempts to obtain rigidity and convenience in changing tools, and any one may have an advantage over the others that might be considered a real merit. The first punches used in machines were made with the stems integral. They were expensive to make and were uneconomical in the use of material. When a punch broke, the steel in the stem was worthless, unless it could be drawn and used in another machine. The system of interchangeable punches led to more economical production methods and decreased the cost of maintenance.

The punch and stem are now made separately and connected by means of a coupling nut, as shown in the illustration of the accompanying table. The point on the end of the punch is used in adjusting to the proper position the centers of the holes to be punched, which have previously been laid out and marked by means of a prick-punch. The operator places the work in the machine, and by bringing the point of the punch sufficiently close to the plate, is able to get the prick-mark directly under it.

There are three types of punches; the flat end, the spiral end, and the wedge end, the last two being commonly called "shearing" punches. Flat punches should always be used when the thickness of the plate is greater than two-thirds the diameter of the hole. If the thickness is less than one-half the hole diameter, much less force is required when a shearing punch is used, because the area of metal being cut at any time is less than the thickness of the plate times the circumference of the hole. Shearing punches are also recommended for cases where a large number of holes are to be punched close together, because they do not distort the plate as much as flat-end punches. When the wedge-end punch is used in making nuts and washers, it is provided with a removable center which may be changed to suit the size of the hole or removed for regrinding.

There are several standards for punches and dies, and these differ greatly. The ones most commonly used are the "Standard" and the U. S. standard; however, a number of manufacturers have their own standards. The diameter of a punched hole is equal to the diameter of the punch, but if there is an appreciable clearance between the punch and the die, the hole will be conical. The "size" of the punch usually means the actual diameter of the punch or the size of hole it will produce, but sometimes it corresponds to the size of rivet that is to be used in the holes punched.

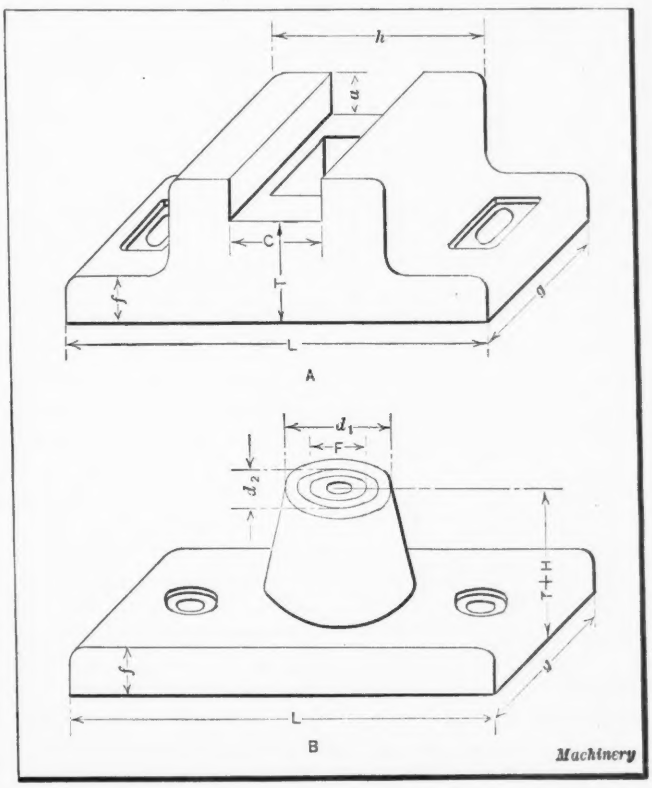


Fig. 1. Punching Machine Die-blocks for Rectangular and Circular Holders, respectively

There is no rational method of determining the proportions of punches. The proportions for U. S. standard punches which will be considered throughout this series of articles are given in the accompanying table. The sizes run from 0 to 11. The die, punch, and coupling nut of a given number fit together. It will be seen that each number is intended for a range of holes, the only difference in the proportions being dimension *A;* for instance, a No. 3 punch is intended for holes from 11/16 to 1 1/16 inches in diameter. Diameter *B* is made equal to the largest value of diameter *A;* hence, dimension *A* for a No. 3 punch varies from 11/16 inch to dimension *B*.

The punches marked "S" have length *D* the same as for the corresponding number; for example, length *D* for a No. 3S punch is the same as for a No. 3 punch. But dimensions *B* and *C* are the same as for the preceding number (or No. 2 in this case). The coupling nut for a No. 3S punch fits a No. 2 punch and a No. 3 stem. This makes it possible to attach a No. 2 punch having a length equal to a No. 3 punch to a No. 3 stem. Two stems, Nos. 3 and 5, and four coupling nuts, Nos. 3, 3S, 5, and 5S, will accommodate punches ranging from 9/32 to 1 9/16 inches in diameter. The seat of the punch in the coupling nut is at an angle of 30 degrees with the axis of the punch.

In the standards of the Cleveland Punch & Shear Works Co. punches between 1/8 and 1 5/16 inches diameter are 2 1/8 inches long, and the same coupling nut can be employed for more than one size by using a bushing or reducer that fits over the punch and has the effect of increasing diameters *B* and *C*. The "Standard" punches may cover a wide range by using different couplings, similar to those of the U. S. standard; however, instead of making a punch of a given size equal in length to another size, a bushing called a "distance block" is used in connection with the punch to produce the desired length.

Punch Stems and Coupling Nuts

The punch stem or stock may be made square or round. The round type is very satisfactory for punching round holes and costs less to make; however, it is not so desirable for punching holes that are not round, because it is likely to turn in the holder and not permit the punch to clear the die. Machines should be fitted with stems suitable for the largest punches the machines are designed to use, but as a rule the stem is made only slightly larger (to the nearest 1/8 inch) than the diameter of the thread in the coupling nut for the size of punch specified. For example, a machine for punching 1-inch holes through 1-inch plate would use either a No. 3 or a No. 4S punch. The diameter of thread for a No. 3 punch is given in the table as 1 13/32 inches, and so the diameter of stem for this punch would probably be 1 1/2 inches.

The diameter of the stem is a matter of serious consideration. If the slide were designed to take a 1 1/2-inch stem and it should be desired to punch a 1 1/4-inch hole through plate 1/4 inch thick, it would be necessary to construct a special stem. This would suggest that the slide in this machine be fitted with a 1 3/4-inch stem; however, the reason for using the 1 1/2-inch stem is that it would not permit the use of a punch greater than 1 1/16 inches in diameter, and the press would be less likely to be overloaded by an operator attempting to punch, say, a 1 1/4-inch hole through 1-inch plate. Many machines have been broken by excessive overloads produced in this way. If this machine were fitted with a No. 4 stem and a No. 4S coupling, it would be equally well protected against overload, unless the operator had access to a No. 4 coupling. It is undoubtedly better to use a No. 4 stem and a No. 3 die if the machine is to be in the hands of careful operators, and this is often done.

Dimension *K* varies with the size of the punch and the class of work done on the machine. If the machine is used only for punching, the values of *K* given in the table are sufficiently large; but if a given machine is also to be used for shearing, the value *S* must be sufficient to accommodate the shearing tools, and in order to span this distance, after the die-block and holder have been made sufficiently thick, the length of the stem must be increased too. Value *S* may be determined by the empirical formula $S=8.25\sqrt[3]{dt}+0.8$; and by making *K* approximately equal to the diameter of the thread on the stem, the die-block will usually be of sufficient thickness.

The thread on the stem should be about two threads longer than the dimension *E* given in the table. The length of the stem in the holder may be about twice the travel of the slide plus 1 inch; or as expressed by the formula, $2.22\sqrt{dt}+1.6$. The total length of the stem should be about $2.22\sqrt{dt}+1.6+E+K$, the value of *K* depending on

whether or not the machine is used for shearing, as previously explained.

The couplings are generally spanner or hexagonal nuts. The diameter of the thread and the distance that the stem enters the nut are given in the table. The plain hole through which the punch protrudes is 1/32 inch larger in diameter than diameter B of the largest punch for which the coupling is to be used. The outside diameter of the spanner nut or distance across flats of the hexagonal nut may be $1.225O + 0.25$, where O is the diameter of the thread. The length of the coupling nut may be made equal to $2.25E + 0.2$.

Dies, Die-holders and Die-blocks

There are two common designs of dies, the flat top and the bevel top. The flat-top die is made slightly higher at the cutting edge than at the periphery to insure contact at the cutting edge. This taper may be 1/16 inch for all sizes up to and including No. 8. There may be a taper of 1/8 inch on dies Nos. 9, 10, and 11. The bevel-top die has beveled serrations running parallel across the top. Dies are marked according to the punch size; those 1/2 inch and under have a clearance of 1/32 inch around the punch, while those larger than 1/2 inch have 1/16 inch clearance. The dimensions of U. S. standard dies are also given in the table.

Die-holders are made either circular or rectangular, depending upon the design of the block. The outside diameter of round holders should be about $1.5F$, where F is the value given in the table for the outside diameter of the largest die to be used in the machine. The length of the holder should equal $2.5F$, and the width $1.5F$. Thickness H of a round or rectangular holder is given in the table. The top of the die should extend 1/8 inch above the top of the holder, making the distance from the bottom of the holder to the top of the die equal to $H + 1/8$. The die is fastened to the holder by means of a set-screw. Some designers place the die directly in the block, as shown at B, Fig. 1, and do not use a holder.

The die-blocks shown at A and B in Fig. 1 are for rectangular and circular holders, respectively. These die-blocks are shown assembled at A and B, Fig. 2. Length L, Fig. 1, of the die-block is usually made equal to the width of the lower jaw of the machine, and is found as follows:

$$L = 12.25\ \sqrt{dt} + 4$$

The distance from the bottom of the slide, when it is in the extreme downward position, to the bottom of the die-holder,

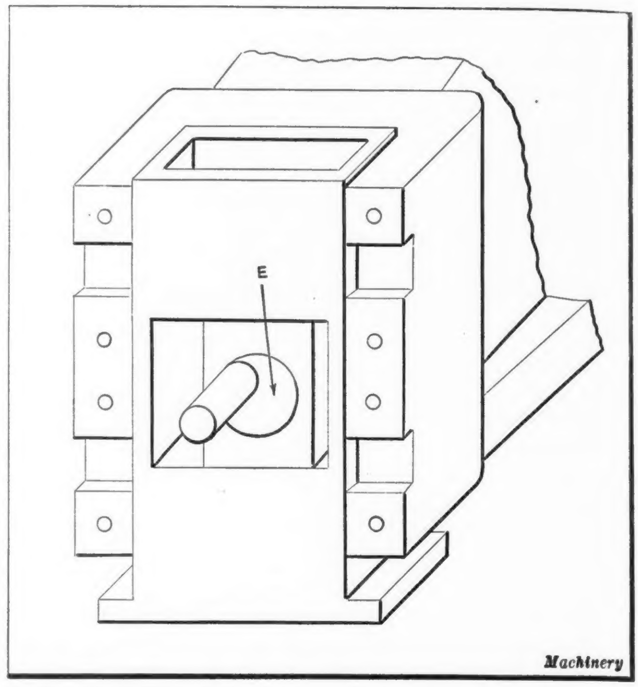


Fig. 3. One Method of designing the Head End of the Frame and the Slide

on a combined punching and shearing machine is approximately equal to $M + H + P$, where $M = D + E + K - P$; these dimensions are taken from the table. The thickness of the die-block T is determined by the formula

$$T = S - (M + H + P)$$

The distance P which the punch enters the die should vary with the size of punch and thickness of plate. It is generally conceded that for ordinary steel plate and structural steel it is not necessary for the punch to go below the top of the die, but it usually enters from 1/64 to 1/8 inch. This is to allow for spring of the frame and wear of the punch and die. The conclusion to be drawn from statements by various authorities is that an allowance of 1/16 inch should be made for grinding the punch and die, and from 1/32 to 1/16 inch for the deflection of the frame. Therefore $P = 1/16$ to $1/8$ inch.

Other proportions for the blocks shown in Fig. 1 are found by the following formulas, in which H and F correspond to the dimensions given in the table:

$a = 0.75H$ $h = C + 2f = 1.6F + 2H$
$C = 1.6F$ $L = 12.25\ \sqrt{dt} + 4$
$f = H$ $d_1 = 2.25F + 0.25$
$g = 3.125F$ $d_2 = 1.5F$

The die-block at A is provided with screws for securing the holder to it, and both blocks have slots in them which allow adjustment when they are being secured to the lower jaw of the frame.

Travel of the Slide

The stroke of the punch or travel of the slide depends upon the greatest thickness of plate and the largest diameter of hole punched. It is desirable to have the punch raised above the plate sufficiently to allow the operator to move the work readily between the punch and die; but it is also desirable to have the stroke as short as possible so as to reduce the twisting moment on the shaft and the force transmitted at the pitch line of the gear teeth. A long stroke permits of a long cut being taken with a bevel shear. The punch is usually passed from 1/16 to 1/8 inch beyond the under side of the plate,

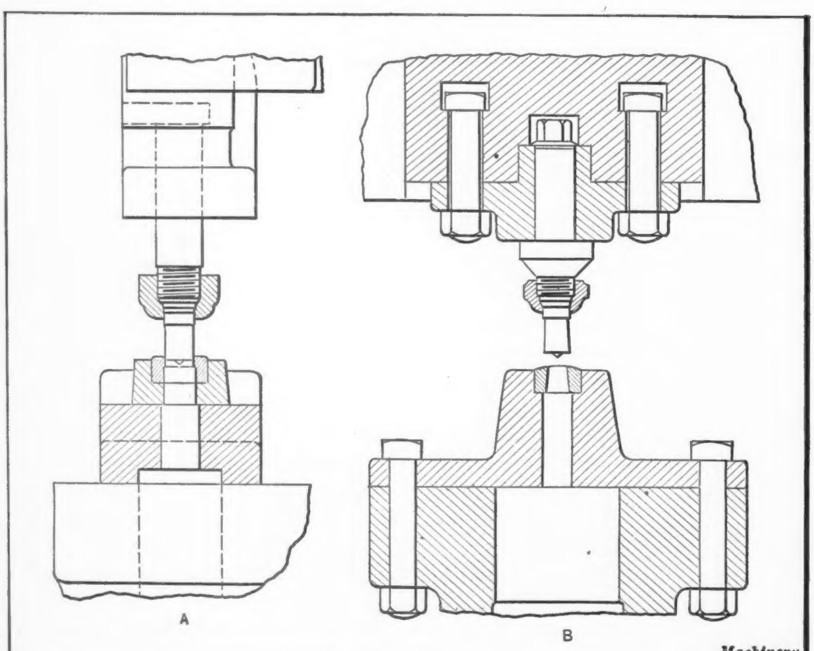


Fig. 2. Sectional Views of Punches and Dies, having Die-blocks like those shown in Fig. 1

and the clearance between the plate and the punch when the latter is at the end of its upward stroke should be about 3/8 inch for a 3/8-inch hole and a 1/4-inch plate, and 1 1/2 inches for a 4-inch hole and a 2-inch plate. In punching 1-inch holes through 1-inch plate, the travel is usually about 1 1/2 inches, and for a 1 1/2-inch hole through the same plate, the travel is usually 1 3/4 inches.

By plotting the values taken from machines made by several different companies, it was found that the travel could be expressed roughly by the empirical formula

$$h = 1.11\sqrt{dt} + 0.3$$

in which

h = travel of slide;
d = diameter of largest hole; and
t = greatest plate thickness;

When the largest diameter of hole is equal to the greatest thickness of plate, this formula is written

$$h = 1.11d + 0.3$$

The slide travel is usually made to the nearest 1/8 inch of the value given by the formulas. The radius e of the path followed by the center of the eccentric on shaft E,

$$DCp = 3.1416Pdt$$

in which

d = diameter of largest hole punched;
t = greatest thickness of plate; and
P = resistance of plate to punching, per square inch.

Assuming $D = C$, $P = 60{,}000$ pounds, and $p = 11{,}750$ pounds,

$$D^2 = C^2 = \frac{3.1416 \times 60{,}000\ dt}{11{,}750} = 16dt$$

Therefore,

$$D = C = 4\sqrt{dt}$$

This value of 11,750 pounds per square inch for the unit pressure gives the same result as an empirical rule which states that the diameter of the eccentric or cam should equal twice the diameter of a round rod having a cross-sectional area equal to the area sheared in punching the hole. This rule may be expressed by the equation,

$$\frac{3.1416}{4}\left(\frac{D}{2}\right)^2 = 3.1416dt$$

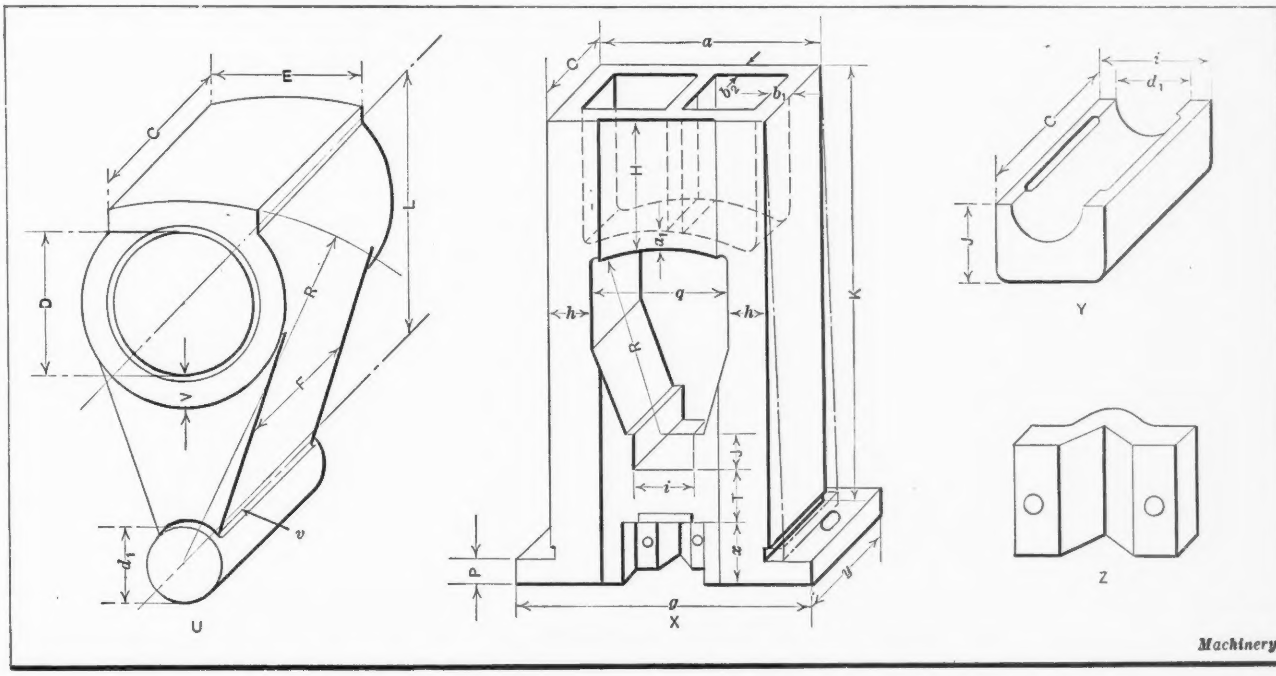


Fig. 4. Details of the Pendulum, Slide, Pendulum Box, and Punch-stem Clamp

Fig. 3, which is employed to reciprocate the slide, is called the "eccentricity," and is equal to one-half the slide travel. It is expressed by the formula

$$e = 0.55\sqrt{dt} + 0.15$$

Designing the Pendulum

The pendulum (also called "pintle" and "pitman") is a special form of connecting-rod which is fitted to the slide in such a way that it is not subjected to tension on either stroke. This eliminates the use of a large wrist-pin which would be subjected to double shear. The pendulums differ slightly in shape, as they may be made of cast iron or steel. The type of pendulum that will be proportioned in this article is shown at U in Fig. 4. It will be assumed that this is to be an iron casting. Diameter D of the eye is determined by the diameter of the eccentric or cam on the main shaft, the eccentric being subjected to a force approximately equal to the maximum force required to punch the hole.

The length of the cam bearing or width C of the slide, as shown at X, is sometimes made equal to diameter D. This bearing is subjected to pressure during only a part of the downward stroke. The allowable bearing pressure per square inch varies from 5000 to 16,000 pounds, depending on the size of the machine and the designer. Equating the total bearing pressure with the total load,

Simplifying,

$$D = 4\sqrt{dt}$$

This formula is satisfactory only for machines ranging from those for punching 3/4-inch holes through 3/4-inch plate to those for punching 3 1/2-inch holes through 2-inch plate, and should not be used for smaller or larger machines.

Small machines operate faster and are more likely to be overloaded and neglected than the larger sizes. For this reason a greater factor of safety is used in their design, this being equivalent to using a variable bearing pressure. It is also more economical to make dimension C greater than dimension D on large machines. These considerations are embodied in the formulas

$$C = 3.5\sqrt{dt} + 0.5$$
$$D = 3\sqrt{dt} + 1$$

The latter value of D is equal to 1 inch plus 1.5 times the diameter of a round rod having a cross-sectional area equal to the area of the metal sheared in punching the hole, and gives much larger values for small machines and smaller values for large machines than is given by $4\sqrt{dt}$. It should be used in designing a punching machine of any size, and will be used in proportioning parts in this article.

The load on the pendulum lower bearing of diameter d_1 (Fig. 4) is approximately equal to the total force required to punch the hole. The bearing surfaces have only a small

relative motion, are subjected to pressure during a part of the downward stroke only, and are free from pressure on the upward stroke, so that the surfaces become well lubricated before each load is applied. Under these conditions it is permissible to use a bearing pressure as great as 20,000 pounds per square inch; however, a pressure of about 18,000 pounds per square inch gives satisfactory results for medium-sized machines. Assuming that the length of the lower bearing equals length C or $4\sqrt{dt}$, and equating the area of the lower bearing times the unit pressure, with the load,

$$Cd_1 \times 18{,}000 = 3.1416dt \times 60{,}000 = 188{,}500dt$$

and

$$d_1 = \frac{188{,}500dt}{18{,}000C} = \frac{10.48dt}{4\sqrt{dt}} = 2.62\sqrt{dt}$$

This formula is satisfactory for machines of medium capacity, but it is better to use $d_1 = 0.5D$, where $D = 3\sqrt{dt} + 1$, which gives

$$d_1 = 1.5\sqrt{dt} + 0.5$$

Formulas for Determining the Slide Dimensions

The details of slides or plungers differ but slightly except in the method of attaching the punch stem. Sometimes the stem is held to the slide by means of a clamp, such as shown at Z, the V-shaped groove in the clamp and that in the slide forming a square opening which gives four contact lines with the punch stem, and thus secures it rigidly. In other designs the stem is attached to a block that is dovetailed into the end of the slide and allows the center of the punch to be located near the edge of the slide, when it is desired to punch small holes. A third method that is extensively used is to secure the stem to a bolster which is bolted to the slide. The sliding block mechanism shown in Fig. 3 is simple to construct, but it is not so satisfactory on account of wear, and is seldom used. There is a greater area to sustain the pressure, but there is also a greater relative motion between adjacent surfaces when the load is applied. No provision is made for taking up wear, and since wear is not uniform, it becomes necessary to refinish the bearing

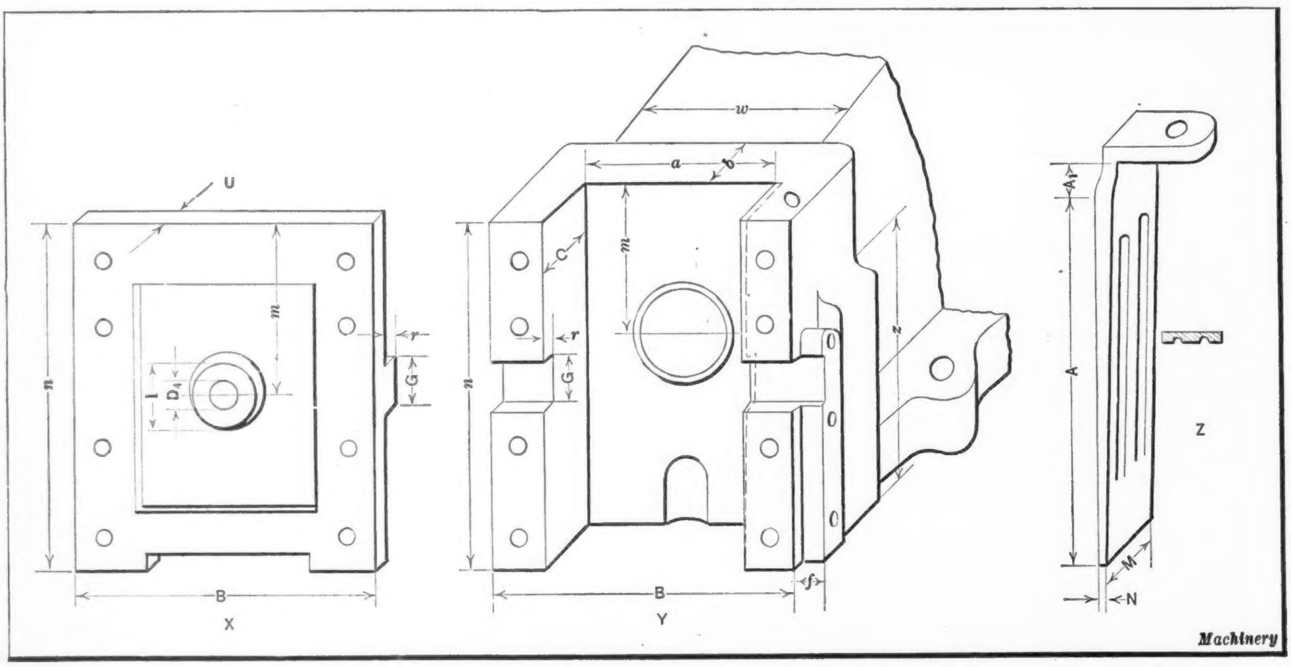


Fig. 5. Details of the Slide Plate, Head End of Machine Frame, and Slide Gib

Distance L between the centers of the pendulum bearings is sometimes made equal to $D + d_1$, but it is better to make it twice the cam diameter minus 1 inch or

$$L = 2D - 1 = 2\,(3\sqrt{dt} + 1) - 1 = 6\sqrt{dt} + 1$$

Thickness V of the metal around the eye, including the bushing, may be determined as follows:

$$V = 0.75\sqrt{dt} + 0.2$$

Some designers consider it essential to use a bronze bushing in the cam bearing of the pendulum, having a thickness of from 3/16 to 3/8 inch. If there is a fillet on the main shaft between the cam and the main journal, the pendulum must be bored to clear it. Radius R of the bearing surface on the top of the pendulum, which coincides with a mating surface on the slide, is found by the formula

$$R = L + 0.5D + V = 8.25\sqrt{dt} + 1.7$$

Width E of this surface is found by the formula

$$E = D = 3\sqrt{dt} + 1$$

The formula for determining breadth F of the web is

$$F = C - 0.5\sqrt{dt}$$

The web may be tangent to the outside of the metal surrounding the eye and the lower bearing, but in order to have free movement of the lower bearing in its box, a small amount of metal should be removed, as shown at v. It is better, however, to bring the web sides nearer together at the bottom, so as to make cut v unnecessary.

in the slide when a worn block is replaced with a new one.

The length of the slide in Fig. 3 may be a little less than that shown at X, Fig. 4, but other proportions may be the same with the exception of the opening in the block, which should be great enough to allow a clearance equal to about $0.25\sqrt{dt}$ between it and the pendulum on each side, and should fit the pendulum and bearing box Y, respectively, top and bottom. The greatest stress produced in the slide is a compressive one, which acts between the pendulum box and the top of the punch stem. The pressure is sometimes taken at the end of the stem by a steel plate from 1/4 to 3/4 inch thick, which is fitted or cast to the slide to distribute the pressure over a greater area. Slides are usually made of cast iron, although many are steel castings. There are instances where it has proved cheaper to replace cast-iron slides that have been weak and failed frequently, with steel slides, rather than to change the patterns for the frame and other parts, which would have been necessary if the dimensions of the cast-iron slide had been changed.

Many of the proportions for the slide shown at X are determined by empirical rules; however, those that admit of any rational derivation have been developed. Some of the dimensions correspond to dimensions of the pendulum and other parts, and are found by the same formulas. However, for the sake of convenience, they will be repeated.

$$C = 3.5\sqrt{dt} + 0.5$$

$$q = 2\,(e + 0.5D + V + 0.2\sqrt{dt} + 0.1) = 6\sqrt{dt} + 1.9$$

$h = 2.5\sqrt{dt} - 0.25$ $\qquad a = 2h + q = 11\sqrt{dt} + 1.4$

$R = 8.25\sqrt{dt} + 1.7$ $\qquad i = 1.5d_1 = 2.25\sqrt{dt} + 0.75$

$f = d_1 = 1.5\sqrt{dt} + 0.5$ $\qquad P = \sqrt{dt} + 0.5$

$$g = a + 1.75\sqrt{dt} + 2.25 = 12.75\sqrt{dt} + 3.65$$

$$n \text{ (see view } Y\text{, Fig. 5)} = 14.4\sqrt{dt} + 6.43$$

$$K = n + 2e + \sqrt{dt} = 16.51\sqrt{dt} + 6.73$$

$K + P = 17.51\sqrt{dt} + 7.23$ $\qquad x = 2.2\sqrt{dt} + 1.6$

$$m \text{ (see view } Y\text{, Fig. 5)} = 0.5n - 2e = 6.09\sqrt{dt} + 2.91$$

$$H = m + e - 0.5D - V = 4.4\sqrt{dt} + 2.36$$

$T = 1.16\sqrt{dt} + 1.07$ $\qquad y = 4.25\sqrt{dt} + 1$

$a_1 = \sqrt{dt} + 0.25$ $\qquad b_1 = 0.875\sqrt{dt} + 0.2$

$$b_2 = 0.75\sqrt{dt} + 0.125$$

The section at the middle of the slide where it is cored to receive the pendulum is subjected to bending when punching or shearing, and the stress is appreciable when the machine is being used as a slitting shear. The analysis of the stresses in this section involves several assumptions, and the results are not so reliable as those obtained by using the formula given for finding value h. The top of the slide when in its lowest position, should be flush with the top of the head at Y, Fig. 5, and the clearance between the flange of the slide and the bottom of the head, when the slide is in its highest position, should equal $\sqrt{dt}$. The clearance between the outside of the pendulum eye and the inside of the slide should be $0.2\sqrt{dt} + 0.1$. At the front and rear of the slide a strip of surface at each edge about $1.25h$ wide and running the full height of the slide is finished to serve as a bearing surface against the plate which holds the slide in place or against the frame, as the case may be. The surfaces between these finished strips are a few thousandths of an inch lower and are not highly finished.

Proper lubrication is essential to satisfactory operation of the slide, and so oil-grooves should be cut in all bearing surfaces. Oil-cups and oil-holes should also be arranged to insure a supply of oil at each bearing and should be so placed that they may be easily reached by the operator. Slides are provided with gibs which may be fastened to either the slide or the head of the frame. In the latter case, the surface in the head which the gib contacts with must be tapered as shown by the dotted lines at Y, Fig. 5. If carried by the slide, it is necessary to taper the slide as indicated by the dot-and-dash lines at X, Fig. 4. The taper is usually from 1/8 to 1/2 inch per foot. The gib is always placed on the side of the slide that is not subjected to pressure due to the angularity of the pendulum or to side thrust on a slitting shear. Not all slides are provided with the partition or web near the top, which furnishes a convenient means of attaching the counterweight. The latter may also be attached to a lug cast on an inside wall of the slide or to a pin passed through holes drilled in the front and rear walls.

Pendulum Box, Punch Stem Clamp, and Gib

The pendulum box is usually made of cast iron, although some designers prefer a steel casting. The depth of the bearing is made slightly less than one-half diameter d_1 of the pendulum to prevent pinching. The box is accurately machined to fit the slide, and is held in position without the use of dowels or screws. The following formulas may be used for determining the dimensions given at Y, Fig. 4:

$i = 2.25\sqrt{dt} + 0.75$ $\qquad d_1 = 1.5\sqrt{dt} + 0.5$

$C = 3.5\sqrt{dt} + 0.5$ $\qquad J = 1.5\sqrt{dt} + 0.5$

The clamp shown at Z is used to secure the punch stem to the slide, as previously mentioned. The center line of the stem does not always coincide with the center line of the slide, as the distance between the stem center line and the front of the slide varies from $0.35C$ to $0.5C$. It will be seen, in detailing the slide and clamp, that the V-shaped channel for receiving the punch stem will come close to the back of the slide, and it is advisable in most cases to reinforce the slide by casting a boss or projection on the back. This lug will be almost flush with the bottom flange of the slide and has a height somewhat greater than x.

The clamp comes flush with the bottom of the slide, and is secured to the slide with cap-screws. These press the clamp against the stem and tend to break it through the middle like a beam. Therefore, in order to determine the thickness of the clamp at the center, assume that the load exerted by each screw is about 5000 pounds per square inch at the root of the thread, consider the cap as a beam, loaded in the middle and supported at the centers of the screws, and assume an allowable bending stress of 4000 pounds per square inch. The clamp is usually provided with a set-screw for holding the stem to it.

The gib is made of bronze or brass, and is machined flat on the bearing side. The opposite side is often grooved as shown at Z, Fig. 5, to facilitate finishing and to reduce the weight. Length A of the finished portion equals length n of the guide surfaces of the head plus the travel of the slide, or, expressed as a formula,

$$A = 15.5\sqrt{dt} + 6.7$$

Width M is made from 1/16 to 1/8 inch less than width C of the slide, while thickness N at the thin end, is made from 1/8 to 5/8 inch, and the taper from 1/8 to 3/8 inch per foot. Distance A_1 should be a little larger than twice the thickness of the nuts used on the adjusting screws. Large machines are provided with two screws for holding the gib in place.

Attaching the Counterweight

All machines having a capacity for punching 1-inch holes through 1-inch plate or greater, and some as small as for punching 5/8-inch holes through 5/8-inch plate, have a counterweight attached to the top of the slide to facilitate placing the punch by hand. There are two methods of mounting the weight; one of these is to carry the weight by a bar or lever having a depth equal to about four times the thickness, and connecting the bar by means of a link to the slide, the fulcrum being fastened to the head of the frame with cap-screws and the lever being located longitudinally with respect to the frame. A somewhat similar arrangement is to connect the lever to the slide by means of a coil spring, which relieves the lever from shocks produced by the inertia of the weight. The second general method is to locate the lever at right angles to the frame and use the spring connection. On quick-acting machines the effects of inertia are so great that it is advisable to use long coil springs instead of weights.

The leverage of the supporting bar varies from 3 to 1 to 5 to 1, and the counterweight should about balance the weight of the slide and pendulum. The weights are usually made cylindrical with a length ranging from 0.75 to 2 times the diameter. The bending stress in the lever due to the counterweight should be about 1500 pounds per square inch when the lever is made of cast iron. If the distance between the fulcrum and the end of the lever that is attached to the slide is too small, the travel and inertia of the weight will be excessive. It is therefore advisable to lay out this linkage to scale, and be sure that the weight clears the frame and does not travel too much.

The Faceplate

Thickness U of the faceplate shown at X, Fig. 5, does not permit of rational solution, but may be found by the formula

$$U = \sqrt{dt} + 0.5$$

Diameter D_4 of the bearing is equal to the diameter of the cam minus the travel of the slide, and may be found by the formulas

$$D_4 = 1.89\sqrt{dt} + 0.7 \text{ (without fillet on cam)}$$

and

$$D_4 = 1.75\sqrt{dt} + 0.7 \text{ (with fillet on cam)}$$

The length of the bearing should equal from D_4 to 1.25 D_4, and the following formulas may be used to find the other dimensions:

$I = 1.75\,D_4$ $\quad r = 0.5\ \sqrt{dt} + 0.125$

$G = 2\,\sqrt{dt} + 1$ $\quad m = 6.09\ \sqrt{dt} + 2.91$

$n = 14.4\ \sqrt{dt} + 6.43$ $\quad B = 15.5\ \sqrt{dt} + 3.4$

The faceplate on machines larger than for punching 1-inch holes through 1-inch plate is sometimes provided with two lugs, as indicated in Fig. 5, while in other instances two steel studs fastened to the frame are inserted in holes in the faceplate to align it, instead of using lugs on the plate. Each stud may have a diameter equal to $1.4\,\sqrt{dt} + 0.75$. There is no rational method of determining the load carried by the studs or cap-screws, used in securing the faceplate to the head. The number of studs or screws varies from six to ten, and their diameter from 3/8 to 1 inch. A rule that has proved very satisfactory is as follows: The total area of the screws or studs should equal the area of metal sheared in punching the hole.

* * *

FIXTURE FOR MILLING AND UNDER-CUTTING CLUTCH TEETH

By J. T. LONGDON

The milling fixture here illustrated was designed by the writer for milling and under-cutting the teeth in three-jaw clutches of the design shown by the two views in the lower left-hand corner of the illustration. The fixture consists essentially of a collet spindle on which the work is mounted, a worm and worm-wheel for rotating the spindle so as to feed the work to the milling cutter, and a pair of cams which give the endwise movement to the spindle that is necessary to produce clutch teeth of the required shape.

The work is placed over the collet which is expanded by the action of spindle *D*. This spindle is drawn inward by means of the capstan wheel *N* and draw-rod *M*. The disk or collar *P* is screwed on the end of rod *M* and tightened in place so that it forms a stop for the latter part, by bearing against the end of part *C*. Key *V* prevents spindle *D* from rotating independently of part *C*. On the end of part *C* is a cam *H*, which is held in place by key *J* and set-screws *O*. The stem of cam *K* is made a push fit in body *A*, and is bored out to receive row *M*. Cam *K* is also recessed to receive collar *P*. Set-screw *L* prevents cam *K* from rotating.

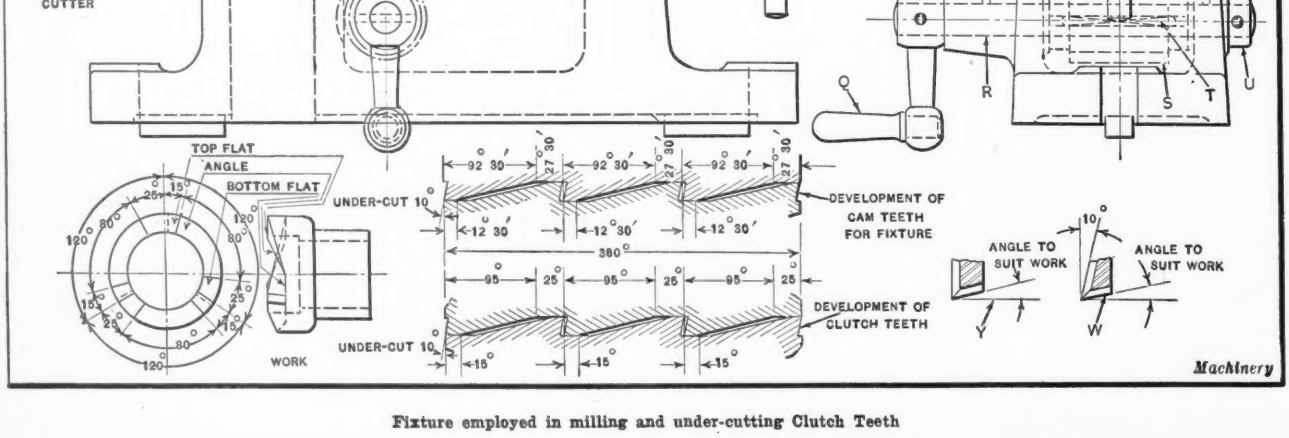
Reference to the illustration will show that after the work is in position and the collet has been expanded, parts *C* and *D* form an integral part, which, in operation, has an inward and outward, as well as a revolving movement in and through bushing *B*, which is a press fit in *A*. The in and out movements are controlled by cams *H* and *K*. A keyway is cut in part *C* to accommodate key *F*, located in worm-wheel *E*. Worm-wheel *E* is, of course, a sliding fit on part *C*. The ratio of the worm and worm-wheel is 40 to 1. Spring *G* serves to keep the cam faces in contact. Spindle *R* carries the ball-crank handle *Q* and the worm *S*. The worm is prevented from rotating independently of spindle *R* by key *T*. Spindle *R* is held in place by collar *U*.

In operation, the ball-crank handle is rotated clockwise, thus causing the worm-wheel to revolve in the direction indicated by the arrow in the view in the upper right-hand corner of the illustration. One revolution of the work or forty revolutions of handle *Q* are required to complete the tooth-cutting operation. To under-cut the teeth, the ball-crank handle is rotated in a clockwise direction until the cam faces are in the position shown. The ball-crank is then rotated in a counter-clockwise direction as far as possible, thereby under-cutting one of the teeth. This operation is repeated for each tooth. In the illustration, *Z* represents the face of the cutter used to under-cut the clutch tooth faces. At *Y* is shown the profile of the clutch tooth milling cutter, and at *W* is shown the tooth profile of the under-cutting milling cutter. These cutters should be as large in diameter as the work will allow, because the surfaces cut will be slightly concave, but the amount of concavity is so small that it is not detrimental to the work.

* * *

THE ENGINEERING PROFESSION

Engineering work has become an increasingly important factor in the progress of civilization and in the welfare of the community. The engineering profession is held responsible for the planning, construction, and operation of such work, and is entitled to the position and authority that will enable it to discharge this responsibility and to render effective service to humanity. That the dignity of their chosen profession may be maintained, it is the duty of all engineers to cooperate in upholding the engineering profession by exchanging general information and experience with fellow engineers and students of engineering and also by contributing to work of engineering societies, schools of applied science, and the technical press.—*From the Code of Ethics of the American Society of Mechanical Engineers*



Fixture employed in milling and under-cutting Clutch Teeth

Cutting Worm Threads

By FRANKLIN D. JONES

WORM threads are cut either by using some form of thread-cutting lathe and a single-point tool, by using a thread milling machine and a disk type of cutter, or by using a gear-hobbing machine. Worm threads should preferably be cut so that the sectional shape of the thread in an axial plane conforms to the shape of a standard involute rack, the included angle of the thread being 29 degrees, and the total depth of the thread groove being equal to 0.6866 × pitch of worm. This rack shape may be obtained by using a properly ground lathe tool set so that the plane of the cutting edges coincides with the axis of the worm; but if the tool is set normal or at right angles to the sides of the worm thread, the sectional shape of the thread in an axial plane will be modified.

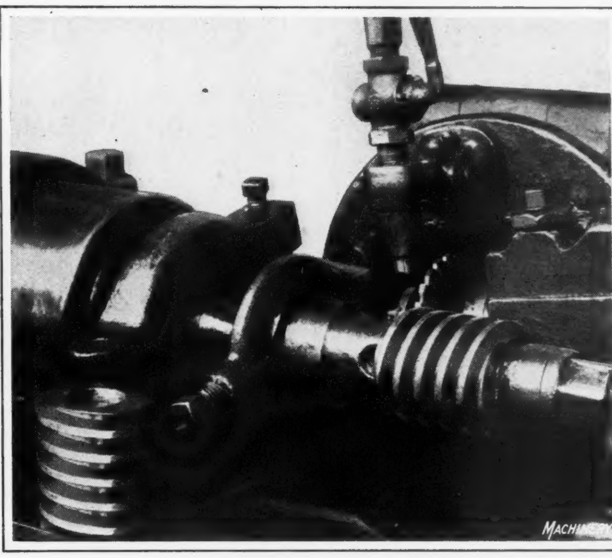


Fig. 1. Milling a Worm Thread

If the worm threads incline considerably from a plane perpendicular to the axis of the work, as in the case of multiple-threaded worms, the use of an ordinary double-sided cutting tool is objectionable, because the tool has an acute angle and considerable positive rake on one side, with an obtuse angle and excessive negative rake on the other side. To avoid an extreme condition of this kind, a single-sided tool may be used for finishing one side of the worm thread at a time. To obtain a good contact between the worm and worm-gear, it is essential to use a hob having cutting edges that correspond to the sides of the worm thread.

In using a thread milling machine, if the cutter has straight cutting edges, the worm thread will not be given the correct shape, the variation depending upon the diameter and helix angle of the worm thread and the cutter diameter. Instead of milling a thread in this manner and then using a hob that is modified to suit the shape of the worm thread, it is better to change the shape of the disk cutter, assuming that the error resulting from the use of a straight-sided cutter is considered of sufficient importance to warrant using a modified milling cutter. The magnitude of this error, as previously intimated, varies according to the relation between the cutter diameter, the worm diameter, and the helix angle of the thread. A cutter is modified to mill a worm thread having a true rack section in an axial plane, by making the cutting edges convex an amount depending upon the related factors just referred to.


Fig. 2. Milling Double-threaded Worm having a Lead of 7 Inches

Ordinary engine lathes are used quite extensively for cutting worm threads. Whether or not lathes can be used to advantage depends on such factors as output required and size and nature of the work. Automatic lathes of the type made by the Automatic Machine Co., Bridgeport, Conn., are efficient for cutting worms on a quantity basis. After the work is placed in position, the movements of the lathe are controlled automatically. Front and rear tools are used, and when the lathe is in operation these tools first move in to the cutting position, the carriage is then traversed, the tools withdrawn at the end of the cut, and the carriage returned to the starting point; this cycle of movements is repeated until the work is finished. For cutting a worm thread, a square-ended roughing tool may be used at the rear, and a finishing tool at the front of the work.

Milling Worm Threads

Thread milling machines are more efficient than ordinary engine lathes for cutting worm threads, as well as for other threading operations within their range. This is because the cutting action is continuous, and a thread may be finished in one cut unless the pitch is quite large, in which case it may be necessary to take two or possibly three cuts. An example of worm thread milling is shown in Fig. 1; this is a detailed view of a Lees-Bradner machine cutting worms for automobile steering gears. The cutter at the rear is inclined to align it with the helix angle of the thread, and it is traversed as the worm blank revolves slowly. The tangent of the angle to which the cutter is inclined may be determined by dividing the lead of the worm thread by the pitch circumference of the worm. An indexing mechanism on the headstock of the machine provides means of rotating or re-locating the work spindle relative to the cutter when multiple threads are being milled.

In using thread milling machines, it is essential to rotate the cutter as fast as possible without dulling it excessively in too short a time, because the higher speed not only increases production but also enables the cutter to form smooth threads. While information on cutting speeds and feeds must necessarily be subject to considerable variation,

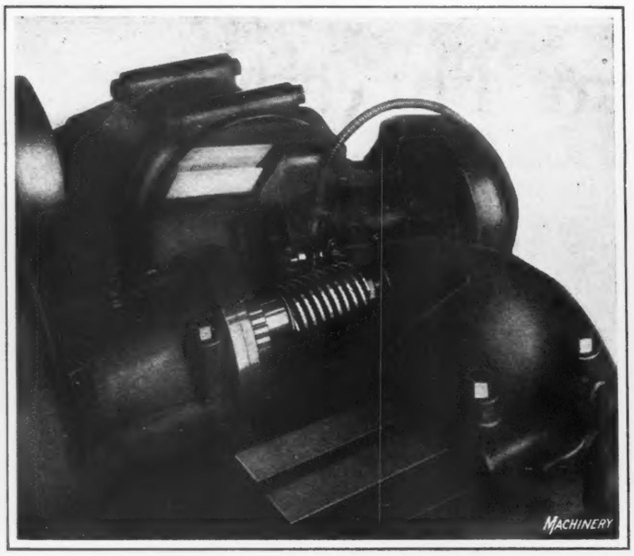


Fig. 3. Gear Generator equipped with Auxiliary Cutter-spindle for milling Worms

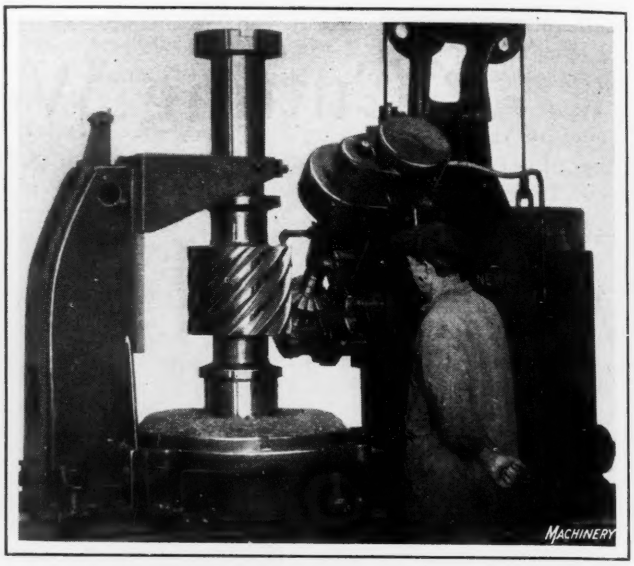


Fig. 4. Milling Twelve-threaded Worm on Hobbing Machine using a Disk Cutter and Hand-indexing

a cutting speed of 100 to 125 feet per minute is a fair average range for milling steel worms. The rotation of the work, which represents the feeding movement, usually varies from about 4 to 7 inches per minute. The speed of the worm shown in Fig. 1 is at the rate of 6 inches per minute.

Another type of thread milling machine is shown in Fig. 2 milling a large worm at the plant of Edwin Harrington Son & Co., Philadelphia, Pa. This is a double-threaded worm having a lead of 7 inches, and three cuts were required for roughing and finishing the thread. As the illustration shows, the cutter is located above the work, and it is set according to the helix angle of the worm thread by adjustment about a vertical axis. A chuck holding the left-hand end of the worm is carried directly by the lead-screw, which is traversed at the required rate through change-gears. This gearing is on the carriage, and serves to control the relative speeds of two worm-gears, one revolving the lead-screw and chuck and the other a nut through which the lead-screw passes. The indexing mechanism for multiple threading is located just back of the chuck.

Milling Worm Threads on a Gear Generator

The application of a Lees-Bradner gear generator to the milling of worms is shown in Fig. 3. The auxiliary cutter-spindle intended for cutting small gears and threading worms is used for this operation. This worm is 3½ inches in diameter, ½ inch pitch, and is cut with a feed at the circumference of 6 inches per minute. The machine is provided with an indexing fixture for use in cutting multiple threads. A fixture of the same general type, but differing somewhat in design, is illustrated in Fig. 5. The center has a notched flange *A*, the number of notches corresponding to the number of threads on the worm to be milled. The driver has a pivoted arm or latch *B*, which is moved from one notch to another for indexing after each thread groove is finished. This particular arbor is used for holding two worms.

A Newark hobbing machine is shown in Fig. 4 milling a twelve-threaded steel worm. The helix angle is 45 degrees, and the normal circular pitch 2.467 inches. An ordinary disk cutter is used, one thread being milled at a time, the same as in a thread milling machine. After each passage of the cutter, the cutter-head is returned by a rapid traverse, and the gear is indexed by hand for milling the next tooth space. The crank for indexing is located at the end of the machine to the right of the operator, and the required indexing movement for the work-table is controlled through suitable change-gears. As the illustration shows, the lower end of the gear shaft is inserted in a cast-iron sleeve which is bolted to the work-table.

Cutting Worm Threads by Hobbing Process

Gear-hobbing machines have been used to advantage for cutting single- and multiple-threaded worms by the hobbing process. This method is particularly efficient for multiple-threaded worms, because all of the threads are finished simultaneously instead of taking separate cuts and indexing, as is necessary in a lathe or thread milling machine. The hobbing machine is geared with reference to the number of threads, as in cutting a helical gear.

In connection with this efficient method of cutting worms, a special form of hob has been developed by Gould & Eberhardt, which is shown at work in Fig. 6 cutting a seven-threaded worm. This hob has fourteen roughing teeth and

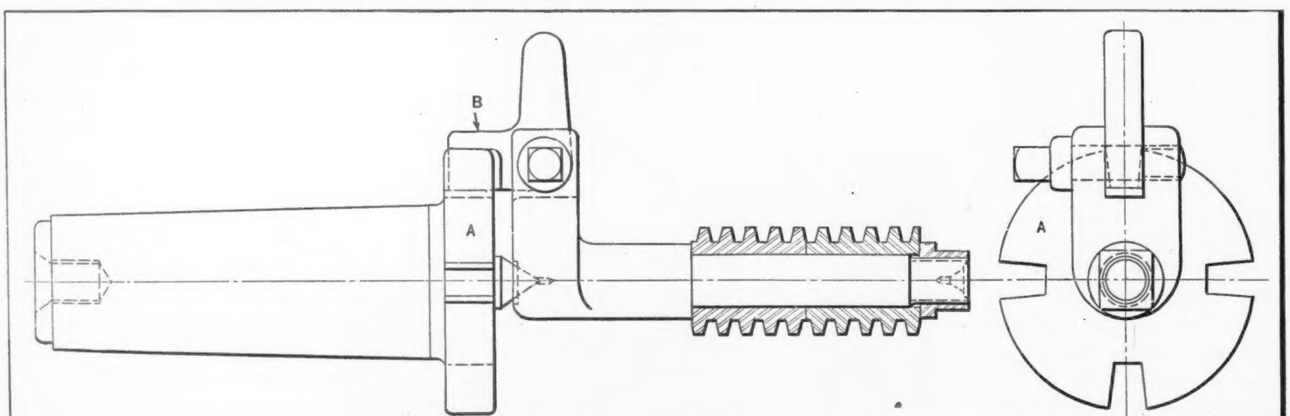


Fig. 5. Indexing Type of Arbor used in milling Multiple-threaded Worms

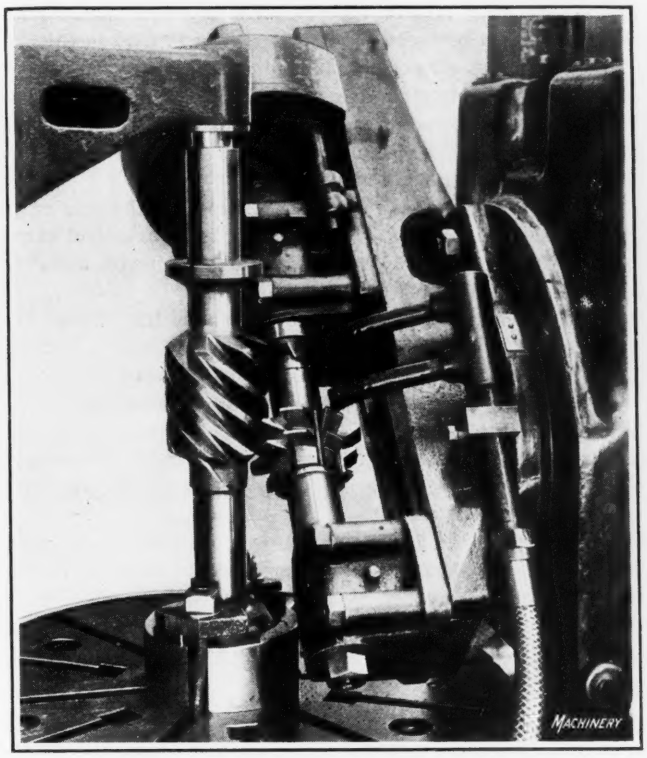


Fig. 6. Cutting Worm Threads by Hobbing Process

three finishing teeth arranged along a helical path, the same as on a regular hob. These teeth progressively increase in width and height to distribute the work of cutting. To prevent interference with the outer half of the worm thread and the cutting of a distorted thread form, the lead of the hob teeth on the following side (as determined by its movement relative to the work) is modified. The worm shown in Fig. 6 has an outside diameter of 4.1 inches, a linear pitch of 1.37 inches, and a face width of 4½ inches. The thread is finished by grinding after hardening.

* * *

FLASH AND FIRE TESTS FOR FUEL AND LUBRICATING OILS

When oil is heated it will give off vapor, the amount of heat necessary to bring this about being governed largely by the nature of the oil. Not all substances, when heated to the vaporizing point, yield an inflammable gas, but this characteristic is found in oils and allied substances. The temperature at which an oil, upon heating in the presence of air, develops vapors, which when a spark is applied will ignite or flash, is called the "flash point." When the heating is continued above the flash point, a temperature is reached at which the vapors are thrown off the surface of the oil in such quantity as to ignite and burn continuously. The temperature at which this occurs is called the "fire point."

Factors that Determine Fire Hazard

The purpose of the flash test, no doubt, has always been to determine the fire or explosion hazards of oils, but the flash point, although probably the most important factor, will not by itself determine the fire hazard of any substance. The fire hazard of a substance is also influenced by the volatility, the boiling point, the vapor pressure, the vapor density, the diffusibility and tendency of the vapors to travel, and their explosive limits in air, the tendency of the oil to chemical change, the quantity of heat liberated per unit of time and volume, the temperature of the flame, the corrosive action and toxic properties of the substance and all its products of combustion, its behavior toward water, both before and after ignition, and the tendency of the substance to leak.

In the case of burning or fuel oils the principles underlying the determination of the flash and fire points are quite important, and much work has been done on the design of flash and fire testing apparatus that will give definite results and will eliminate the personal equation of the operator. These all, however, fall short of giving a physical constant that definitely determines any property of the oil that cannot be determined more accurately in some other manner, as by evaporation or distillation tests.

In the case of lubricating oils, however, flash and fire points have practically no value in indicating lubricating qualities. The flash and fire points of lubricating oils are all sufficiently high to show that there is practically no fire hazard, and even in special cases where these determinations might give indications of constituents of too low boiling points, these can be determined much more accurately and satisfactorily by evaporation and distillation tests. Where specifications still demand that flash and fire points of lubricating oils be taken, the open cup type of tester will give satisfactory results. In making the tests, the points given in the following which were set forth in a U. S. Bureau of Mines publication, should be carefully considered.

Factors that Influence Tests

1. First of all, the conditions under which flash testing is done should always be comparable. Tests should always be repeated, using fresh samples of oil.

2. On account of the influence of barometric pressure on the flash point, final observations should be corrected for barometric pressure, using a proper correction table. A rise of 1 millimeter in the barometer effects a rise in flash point of about 0.038 degree C.

3. The shape and size of the cup in which the oil is heated is of importance. The dimensions of the oil-cup in the Cleveland tester are practically standard.

4. The size of the thermometer bulb has to be taken into consideration in testing for flash point. It is customary to prescribe the kind of thermometer to be used.

5. The rate of heating should be confined to relatively narrow limitations, for it has been definitely proved that a particular oil, when heated at a given rate, will show a different reading if the rate of heating is more or less rapid. An oil that has been heated more rapidly than the specified rate will, as a rule, show a lower flash point reading. When a longer time than specified is allowed to bring the temperature of the oil up to the flash point, the reading of flash point is, in general, higher.

6. The size of the test flame should be constant. A large test flame generally brings about a lowering of the flash point.

7. The test flame should never be applied to an oil more frequently than the directions for operating the instrument demand. Repeated application of the test flame will bring about a destruction of the vapors without producing the actual flash.

8. Samples of oil containing water in the form of an emulsion or otherwise should be previously heated to a point below the expected flash point and the water allowed to settle out. Only an oil practically free from water should ever be placed in the flash test-cup on account of the danger of foaming and frothing, which will frequently cause the cup to overflow. The presence of water vapor makes the determination of the flash point very uncertain, and the presence of 1 per cent of water will prevent flashing entirely. Even smaller quantities will bring about increases in temperature at which the flash point is observed.

9. The efficiency and accuracy of a flash-cup apparatus is, to a large degree, commensurate with the extent to which the personal equation is eliminated. The most satisfactory instrument for the purpose of flash-point testing is one whose manipulation is entirely mechanical and automatic.

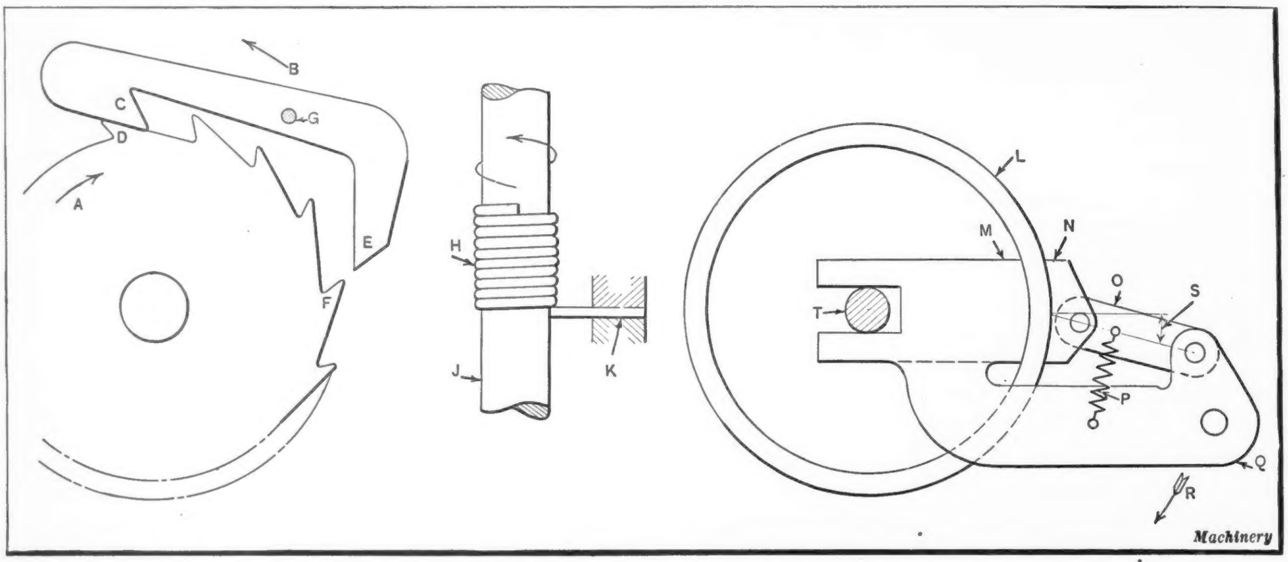
SILENT AND FRICTION RATCHETS

By FREDERICK FRANZ

The writer read with interest the article "Ratchet Mechanisms" which appeared in March MACHINERY on page 536, and was prompted to present the following supplementary description. The three types of ratchets here described have proved highly satisfactory in actual service, and will doubtless be of interest to many readers.

The ratchet mechanism shown at the extreme left in the accompanying illustration has a double-ended pawl which operates silently. When the ratchet wheel turns in the direction indicated by arrow *A*, or when the pawl rotates in the direction indicated by arrow *B*, the end C of the pawl is raised by tooth *D*, thus bringing the end *E* into position to be engaged by tooth *F*. The engaging faces of the teeth are sloped so that the pawl will slide to the root and obtain a full contact. No spring is attached to the pawl.

When used as a feeding device, a frictional resistance, such as a friction washer placed on the fulcrum pin *G*, must be provided to eliminate rattle and insure the proper functioning of the pawl. When used simply to prevent the reversal of either member, no frictional resistance is necessary.



Three Types of Ratchet Mechanisms of Unique Design

This type of ratchet gives good service on the spring motor of a certain make of talking machine. In laying out a ratchet of this type it should be borne in mind that one of the pawls is just on the point of passing the tip of one of the teeth when the other pawl is midway between the tips of two teeth. It should also be noted that this type of ratchet, when used as a feeding mechanism, provides for feeding or indexing in multiples of one-half of a tooth space.

The friction ratchet shown in the central view of the illustration is also used to a considerable extent on talking machines. A close-wound coil spring *H* is assembled on the main spring shaft *J*, and has one end fixed at *K*. The inside diameter of the spring is slightly less than the diameter of the shaft *J* so that it normally grips the shaft. A torque in the direction indicated by the arrow tends to open the spring an imperceptible amount, beginning at the free end, until the friction is overcome. The shaft then turns freely. A torque in the opposite direction, however, increases the friction between the spring and shaft, owing to the "belt-like tension," and thus locks the shaft. Square wire instead of the round wire shown will perhaps prove more durable.

The view at the extreme right-hand side of the illustration shows the principle of a friction ratchet used for varying the quantity of tobacco fed to a certain make of tobacco machine. The flange *L* of the friction wheel is gripped between the body *M* and shoe *N*. The friction surfaces are kept in contact by means of a light spring *P*. When the arm *Q* moves in the direction indicated by the arrow *R*, body *M* and shoe *N* merely slide over flange *L*, but when it moves in the opposite direction, the mechanism is friction-locked, so that arm *Q*, body *M*, shoe *N*, and link *O* all move together as a solid piece with the wheel.

The advantage of this construction is that the sliding or friction surfaces have a comparatively large area and therefore great durability. This has the disadvantage, however, that, should a heavy film of oil accumulate on flange *L*, the ratchet will slip unless the angle *S* is made not larger than 7 degrees. A thin layer of oil absorbed on flange *L* will not cause the ratchet to fail. In designing this type of ratchet, care should be taken to see that body *M* is made very rigid. Provision should also be made for a radial movement of body *M*; this may be done by slotting the end to fit the central shaft *T*. Flange *L* and body *M* may be made of cast iron, and shoe *N* of soft steel.

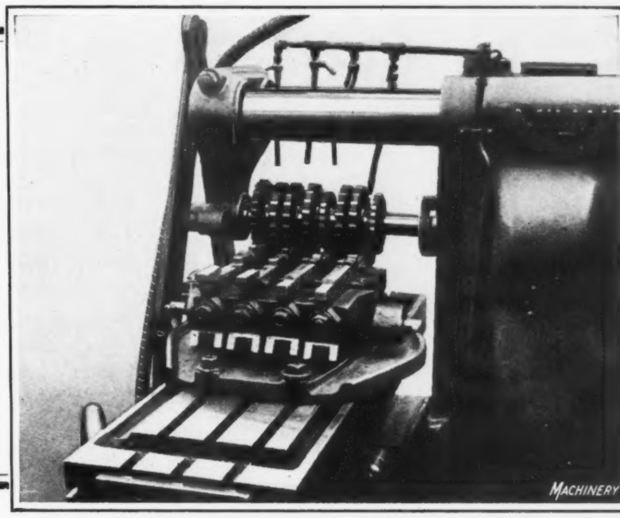
In the article in March MACHINERY, reference was made to cutting the acting side of the ratchet tooth at a considerable angle in order to insure the full engagement of the pawl and tooth. It has been the writer's experience that this practice is not permissible in some designs, as, for instance, in the standard type of pawl which is engaged by means of a spring; in this case the spring should be made strong enough to insure the engagement of the pawl. Undercutting the ratchet teeth is not always permissible in high-speed machinery, or where heavy parts are to be driven. With the under-cut type of ratchet tooth it is possible for the ratchet wheel or pawl—as the case may be—to gain considerable speed or velocity on the reverse movement before the pawl engages the ratchet tooth, thus resulting in shock to the mechanism.

In the article referred to, it was also stated that centrifugal force tends to assist the action of the pawl in an internal ratchet. While it is evident that centrifugal force tends to keep the pawls in engagement with the driven member (while the latter is being driven at high speed by the pawls), it is also evident that centrifugal force is of little or no assistance in forcing the pawls into engagement with the teeth on the driven member, because when the pawl is about to engage the ratchet teeth at the beginning of its stroke the velocity is very low and there is no centrifugal force acting. Centrifugal force would therefore seem to be of no assistance in forcing the pawl into engagement with the ratchet teeth, although it may tend to maintain the engagement after the mechanism is in motion.

Investigation of Tooling Methods

How a Careful Study of Tooling Equipment Often Results in Improved Methods

By JOSEPH P. LANNEN
Tool Supervisor, Paige-Detroit Motor Car Co.
Detroit, Mich.



THE executive confronted with the problem of reducing manufacturing costs may profit greatly by investigating the production possibilities of the available machine tool equipment. An investigation of this kind will often give valuable results if the fundamental principles governing this work are recognized and properly applied. The successful investigator in any line of endeavor is the man who constantly questions the "how and why" of the present way of doing things, and determines whether or not there is a better method of doing them, by turning over in his mind every conceivable means for improvement. He must be guided by the fundamental laws and principles governing the subject at hand, his past experience, and his ingenuity.

Principles Governing Efficiency of Machine Tool Production

The following principles govern the maximum efficiency of machine tool production:

1. The full capacity of the machine must be utilized.
2. The idle man and idle machine time must be reduced to a minimum.
3. The work must be clamped and released in the shortest possible time, except where the length of the process is limited by the speed of the machine.
4. The cutting process, except in planers and shapers, must be completed with the shortest possible table or spindle travel.
5. The cost of tooling must be commensurate with number of parts to be produced.
6. The required daily production must be attained.

Questions to be Considered in Investigation

The investigator or tool engineer who carries out this work may well ask himself the following questions embodying the principles stated.

A machine tool has a certain capacity limited by power and range; is it possible to use more of this capacity than is being used?

Can a number of identical parts be machined at one traverse of the cutting tools or the work?

Can a number of surfaces on a part be machined, or a number of holes be drilled, in one operation?

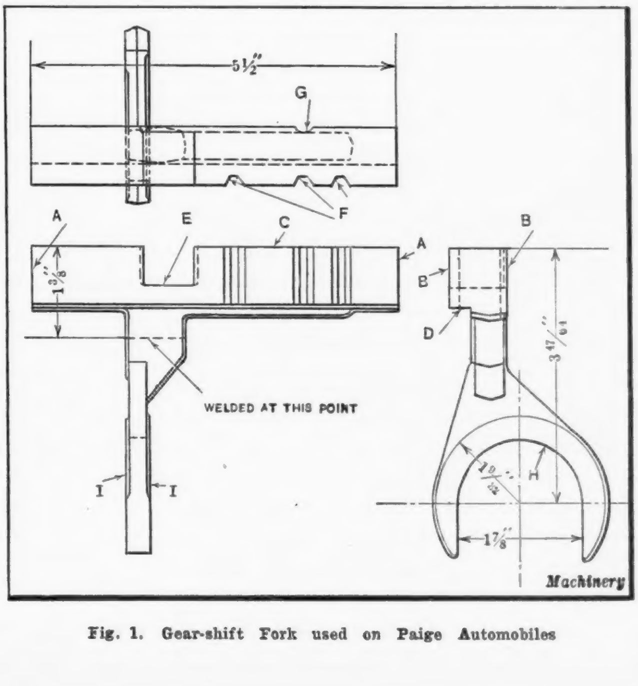


Fig. 1. Gear-shift Fork used on Paige Automobiles

Is the idle man and idle machine time reduced to a minimum by the use of reciprocating fixtures, indexing jigs, etc.?

Are the tools designed in a manner that will permit the cut to be completed with the shortest possible table travel?

Can the tool upkeep cost be reduced by a change in machining methods?

Can one operator run several machines?

Can the loading and unloading time be reduced?

Will the new method give the required daily production?

Will the cost of producing the ultimate number of parts required, combined with the cost of the tools, be reduced to the lowest possible figure?

While it is evident that all these questions cannot be applied to every machine operation investigated, no problem will arise that will not be governed by some of them.

Investigation of Cost of Manufacturing Gear-shift Fork

The results of an investigation instituted to reduce the cost of manufacturing the gear-shift fork used in the transmission of the Paige automobile will now be considered. This part is illustrated in Fig. 1; the reference letters refer to the different surfaces machined. The gear-shift fork was formerly furnished by an outside concern, but at the completion of the contract, the tooling equipment was taken over by the Paige-Detroit Motor Car Co., and used for manufacturing the part until an investigation pointed out the inefficiency of the tooling. The fork and shank are forged separately, and after the shank has been partly machined it is electrically welded to the fork, and the machining operations are then completed. Both the old and new methods of handling the part will be described, so as to give an idea of the efficiency of the new method as compared with the old.

Old and New Methods of Machining Gear-shift Fork

Fig. 4 shows the sequence of operations in the old method; the letters in this illustration refer to the same surfaces as those in Fig. 1. The operation sheet is presented in Fig. 2. It gives the loading and unloading time combined in the "Loading" column, and the cutting time

OPERATION SHEET
Old Method

No.	Name	Loading Time, Min.	Cutting Time, Min.	Daily Production
1	Straddle-mill ends of shank	....	0.63	762
2	Straddle-mill sides of shank	0.72	1.24	245
3	Mill bottom of shank........	0.33	1.05	348
4	Weld fork to shank........	0.40	0.08	1000
5	Mill flash raised by welding..	0.36	0.11	1002
6	Mill top of shank..........	0.48	1.15	294
7	Mill shifter slot............	0.59	0.87	328
8	Mill V-shaped grooves......	0.64	0.52	414
9	Mill circular groove........	0.46	0.30	632
10	Mill fork..................	0.97	3.08	118
	Total Time............	4.95	9.03	

Fig. 2. Loading Time, Cutting Time, and Daily Production of Each Operation in the Old Method

OPERATION SHEET
New Method

No.	Name	Loading Time, Min.	Cutting Time, Min.	Daily Production
1	Straddle-mill ends of shank	....	0.63	762
2	Straddle-mill sides, bottom and top of shank.........	....	2.07	232
3	Weld fork to shank.........	0.40	0.08	1000
4	Mill shifter slot, flash raised by welding V grooves, and circular groove..........	....	1.90	252
5	Drill throat of fork.......	0.20	0.50	685
6	Straddle-mill fork and mill sides of throat..........	0.10	1.40	320
	Total Time.............	0.70	6.58	

Fig. 3. Operation Sheet of the Improved Method which shows the Reduction effected in Manufacturing Time

as well as the daily production for each operation. Fig. 3 shows the operation sheet for the new method, and Fig. 5 illustrates the sequence of operations in this method.

The first operation in the old method, as shown in Fig. 4, consisted of straddle-milling ends *A* of the shank to length. Two reciprocating fixtures were employed, one of which was fed past the cutters while the other was being loaded. The production on this operation was 762 pieces per eight-hour day. The loading and cutting time was so nicely balanced that nothing could be gained by changing the operation, and so it is still followed in the improved method. The second operation consisted of straddle-milling two sides *B* of the shank. Three pieces were loaded in the fixture and a gang of cutters employed, the daily production being 245 pieces. The third operation was milling the bottom *C* of the shank, three pieces being loaded, end to end, in a string of fixtures, and the stock removed by using an end-mill.

Investigation showed that the second and third operations were not tooled efficiently. The set-up of the second operation was not planned to eliminate idle time, and in the third operation, the machine was not loaded to its capacity. For these reasons the two operations were combined in the new method, together with the sixth operation of the old, in which surface *D* of the shank was milled. The sixth operation in the old method was also inefficient, because the full capacity of the machine was not utilized nor idle time eliminated. In the second operation of the new method, Fig. 5, sides *B*, bottom *C* and top *D* of different parts, are straddle-milled in one traverse past the cutters, two pieces being completed each time. Idle time is eliminated by employing an indexing fixture that permits one group of parts to be unloaded and replaced while the other group is being machined. This operation is shown in the heading illustration; the daily production obtained is 232 pieces.

The fourth operation in the old method, Fig. 4, consisted of welding the fork and shank together. No improvement could be made on this and so it is the third operation in the new method. The fifth operation in the original method was milling off the flash raised in the welding operation, and the seventh, eighth, and ninth operations consisted of milling shifter slot *E*, V-grooves *F*, and circular groove *G*.

Combining the Fifth, Seventh, Eighth, and Ninth Operations

When the fifth, seventh, eighth and ninth operations were performed separately in the original method, idle time was not eliminated and the machines were not loaded to their full capacity. By the new method these steps have been combined in the fourth operation. A series of fixtures is provided, mounted on a baseplate and furnished with means for adjusting their relative positions. This arrangement aids in setting up and permits compensation for wear and grinding of the cutters. The work is placed progressively

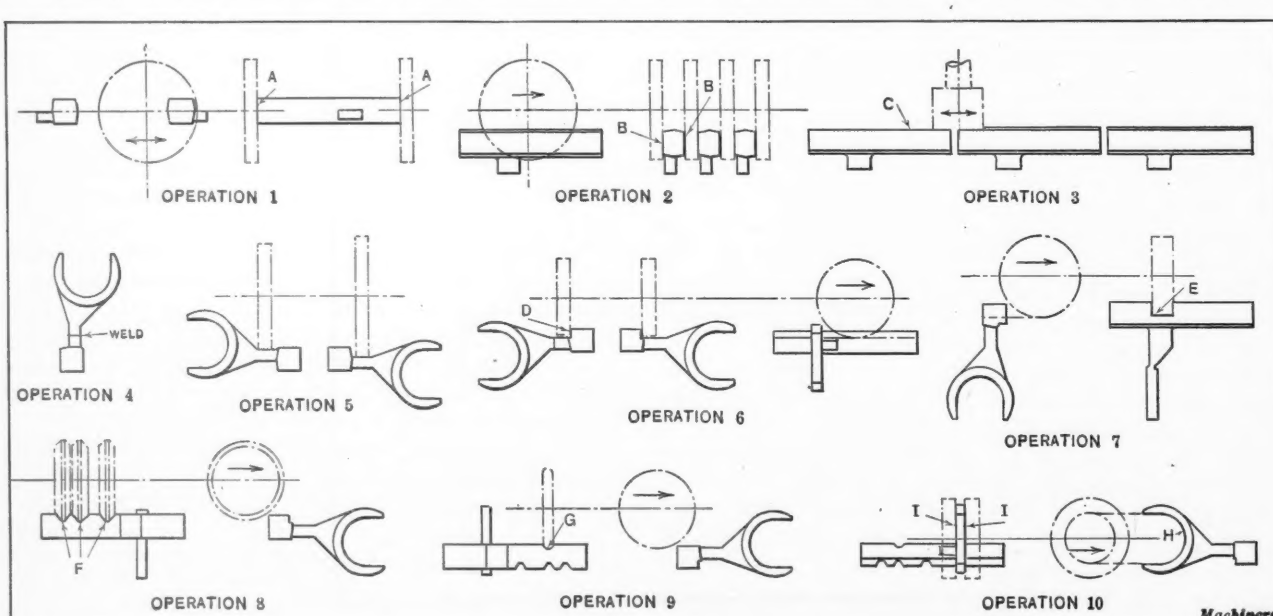


Fig. 4. Sequence of Operations in the Original Method of manufacturing the Gear-shift Lever

in these fixtures, the four operations on a part being completed during each cycle.

The flash raised by the welding operation is milled from one side of the fork while it is in the first fixture, and from the remaining side while it is in the second fixture. The slight radius left on the work by the contour of the cutters employed in this step is of no consequence. The shifter slot *E*, Fig. 5, is milled in the third fixture. These first three cuts are made while the milling machine table is fed to the right by power. Work is placed in the remaining two fixtures while this step is in process, and then when the power feed is released, the table is first fed by hand to a positive stop and then again by hand to the left, after which the power feed is once more engaged to mill the three V-shaped grooves *F* and the circular groove *G* on the remaining two pieces.

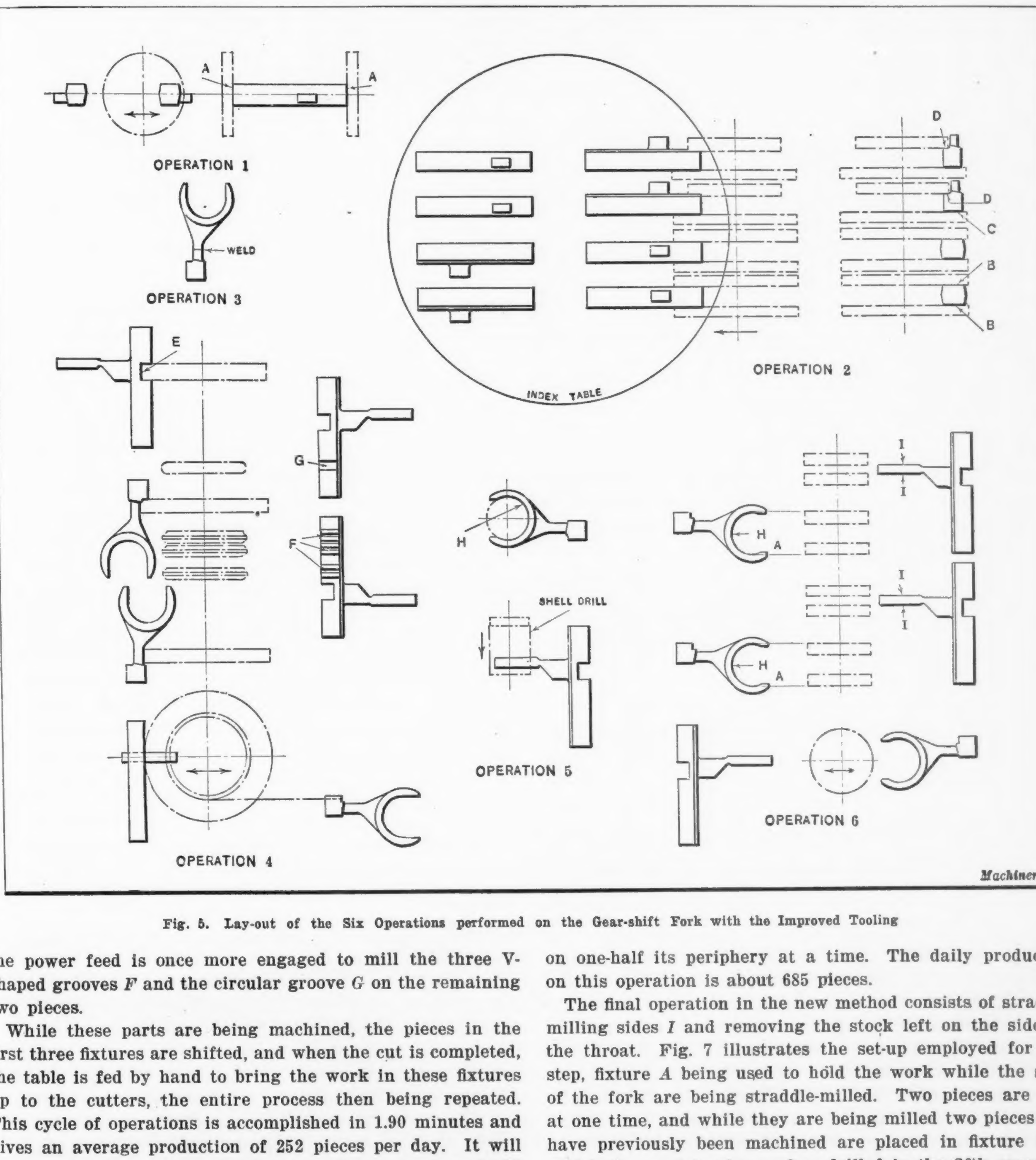


Fig. 5. Lay-out of the Six Operations performed on the Gear-shift Fork with the Improved Tooling

While these parts are being machined, the pieces in the first three fixtures are shifted, and when the cut is completed, the table is fed by hand to bring the work in these fixtures up to the cutters, the entire process then being repeated. This cycle of operations is accomplished in 1.90 minutes and gives an average production of 252 pieces per day. It will be apparent that the use of this set-up effects a saving of 1.95 minutes per part on the five cuts. This rate of production could not be obtained without employing cam-operated quick-acting clamping devices.

Final Operations on the Part

Milling opening *H* and sides *I* of the fork was the final operation in the original lay-out, one piece being milled at a time by a gang of three cutters. This method had several objectionable features: Chips would wedge between the two outside cutters and clog the teeth of the cutter used for milling the throat of the fork. Besides, the latter cutter had to scrape through the scale of the throat, and for this reason would not stand up well. To avoid tool trouble, this operation was subdivided in the improved method, the throat being drilled with a shell drill in the fifth operation; this step is illustrated in Fig. 6. The piece is clamped by a sliding plunger operated by cam *A* which forces the shank of the shifter fork into groove *B*. The lower side of the fork rests on a spherical equalizing washer *C*. The shell drill is piloted both above and below its cutting face so as to overcome the side thrust caused by the tool cutting only on one-half its periphery at a time. The daily production on this operation is about 685 pieces.

The final operation in the new method consists of straddle-milling sides *I* and removing the stock left on the sides of the throat. Fig. 7 illustrates the set-up employed for this step, fixture *A* being used to hold the work while the sides of the fork are being straddle-milled. Two pieces are held at one time, and while they are being milled two pieces that have previously been machined are placed in fixture *B* in which the semicircular surface drilled in the fifth operation is located in the proper relation to cutters *C* by means of cam-actuated swinging clamps, one of which is seen at *D*. The pieces in fixture *B* are milled while the work is being changed in the other fixture. This set-up gives a production of 320 pieces per day, the principle of loading the machine to capacity and reducing idle time being observed here as in preceding operations. The improved method of machining this gear-shifter fork saves the time of three men and

three milling machines, and reduces the time per piece 6.7 minutes. The savings effected by the new method paid for the new tooling equipment in 193 working days.

The practice of grouping operations is common in screw machine work, but even more efficient results are obtained when the practice is applied to milling. The cutters used on a milling machine have a great number of teeth or cutting edges, while on a screw machine nearly all cuts are taken by tools having a single cutting edge. This means an advantage for milling in the length of time between re-sharpenings. Fig. 8 shows an operation on a multiple-spindle drilling machine in which ten holes are drilled in four faces of a water-pump housing casting at one passage of the drills, four parts being mounted on the machine at one time. The partly machined casting is first placed in the left-hand position of the twin drill jig *A*, and advanced consecutively to the right-hand position on and through jigs *B* and *C*. As each piece is advanced a new one is substituted in the left-hand position of jig *A*, so that one piece is finished at each passage of the drills.

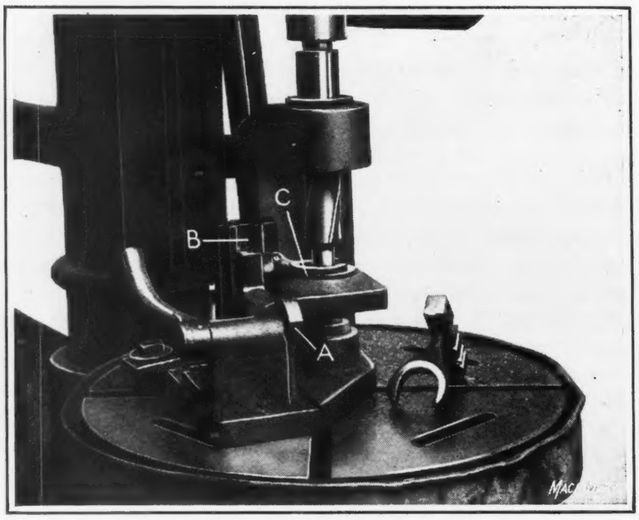


Fig. 6. Drilling the Throat of the Fork

The loading time is 0.72 minute, and the drilling time 0.33 minute. The machine is idle while the jigs are unloaded and loaded, an investigation having shown that the additional cost of an indexing table and a duplicate set of drill jigs would not be justified by the total number of parts to be produced. It was also determined that the present method of drilling effected a substantial saving as compared with locating the work in a jig and drilling one face at a time.

* * *

INDEXING DEVICE FOR DRILLING EQUALLY SPACED HOLES

By HOWARD W. HOUSE

The indexing fixture described in the following was devised by the writer for use in drilling twelve equally spaced holes through a machine steel collar about 3/4 inch in diameter by 3/16 inch thick, having a central hole 5/16 inch in diameter. The holes were required to be drilled on a circle having a diameter of about 9/16 inch. A gear approximately 4 inches in diameter with 60 teeth was selected from a lot of miscellaneous gears to serve as an indexing plate. Of course, any gear of a suitable size, the number of teeth of which could be divided by 12 without a remainder, would have served the purpose.

A machine-steel stud was next turned up with a pilot at one end which was a close fit for the central hole in the collar to be drilled, and the body of this stud was made a force fit in the hole of the hub of the tooth gear. When pressed into the hole in the gear, the body of the stud projected far enough beyond the face of the hub to give it a good bearing in a drilled and reamed hole in a cast-iron plate or base. A small hole was next drilled in the cast-iron base midway between two of the teeth of the gear. This hole was enlarged by drilling (with the gear removed) until a piece of close-fitting drill rod inserted in the enlarged hole would make contact with the sides of two of the gear teeth and thus prevent any play or movement of the gear.

This improvised indexing device was clamped to the drilling machine table and properly located under the drill spindle. A flat drill was used to spot the collar, which was mounted on the pilot end of the stud previously referred to. The work was held in place on the pilot by a screw and a washer. The indexing from one position to the next was accomplished by simply removing the drill rod plug, rotating the gear through five tooth spaces, and then inserting the drill rod plug again.

* * *

CATALOGUES DESIRED IN BRAZIL

W. L. Schurz, American commercial attaché at Rio de Janeiro, Brazil, desires to receive catalogues of machinery of all kinds that might be of interest in Brazil. Catalogues should be mailed to the Industrial Machinery Division, Bureau of Foreign and Domestic Commerce, Washington, D. C., and should be marked on the outside front cover: "To be forwarded to W. L. Schurz, American Commercial Attaché, Rio de Janeiro, Brazil." Manufacturers who have agents in Brazil should indicate their names and addresses on the printed matter. It would be well to furnish more than one set of printed matter, as it frequently is desirable to have extra copies to give to interested inquirers. The language employed in Brazil is Portuguese; if printed matter is not available in that language, French would be preferable to Spanish.

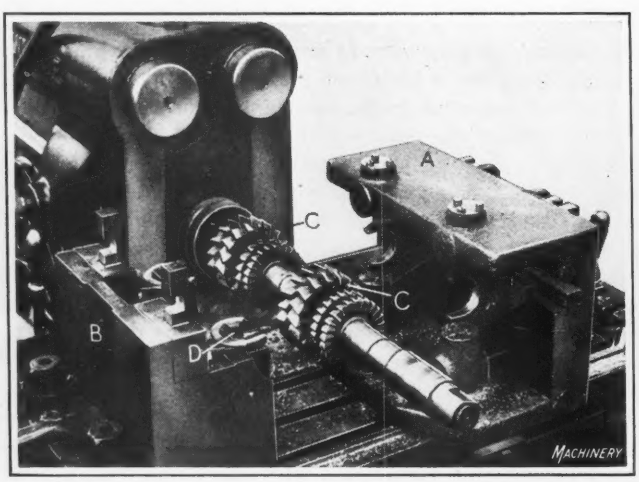


Fig. 7. Tooling employed for milling the Sides of the Fork and the Straight Sides of the Throat

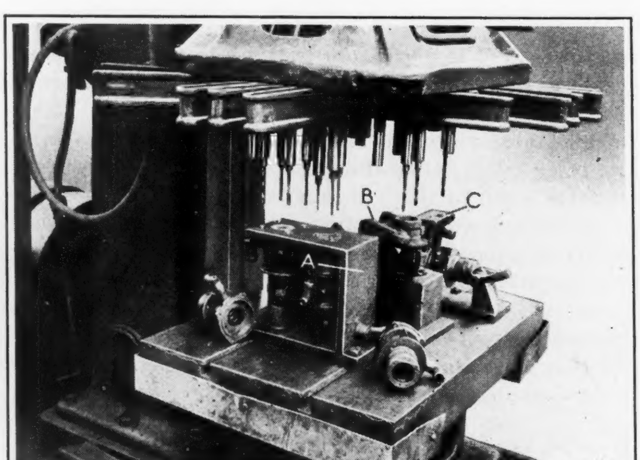


Fig. 8. Equipment by Means of which Ten Holes are drilled in a Part at Four Passes of the Drills

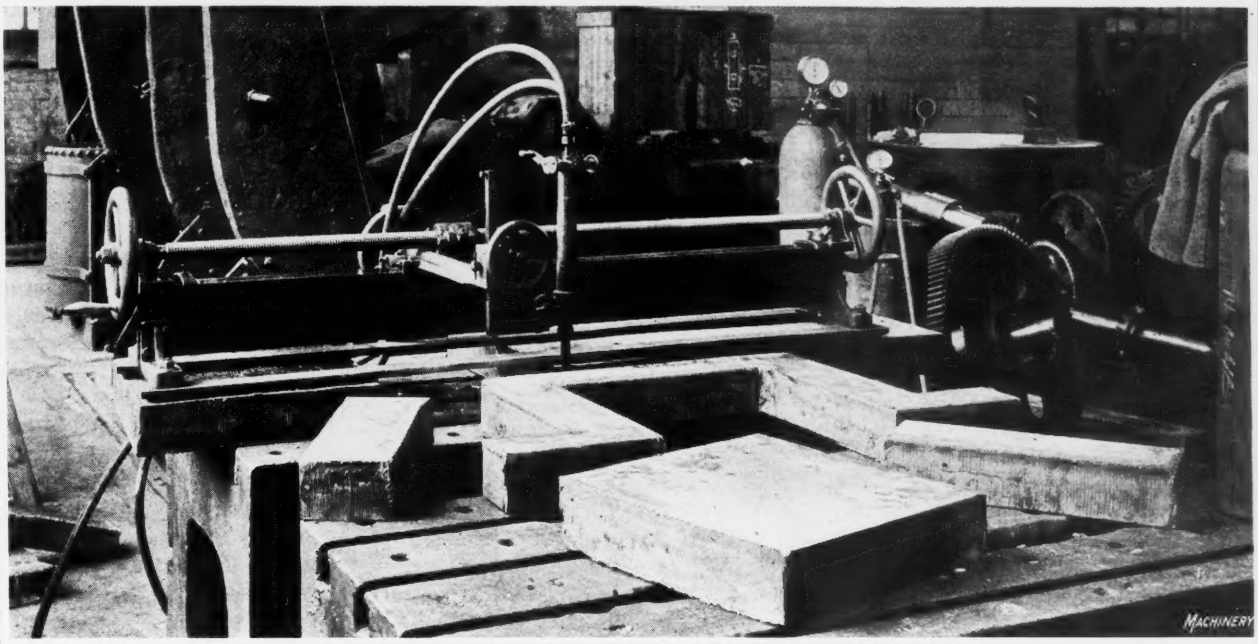


Fig. 1. Cutting Roll Housings from Steel Slabs with Oxy-acetylene Blowpipe in Conjunction with a "Straight-line" Cutting Machine

Oxy-acetylene Process of Cutting Metals

Advantages of This Method and Some Modern Applications

THE cutting of metals with the oxy-acetylene blowpipe is finding an increasing number of applications in the regular manufacture and production of machinery and machine tools. The savings made possible by these applications are in many cases as important and the benefits derived from the use of the process are as great as in the more spectacular and more widely known applications. The scrapping of a battleship, or the cutting with an oxy-acetylene blowpipe, of a tangled mass of twisted structural steel after a great fire, for instance, may attract front-page space in the newspapers; but the savings and economies effected daily in the production of machinery parts will not attract such wide attention, although in point of actual saving the latter may be far more important than the former.

Probably the greatest savings in the machinery field accomplished with the oxy-acetylene cutting process are made through the elimination of special forgings and castings, and the substitution of parts cut from stock sizes of machinery steel, steel plate, bars, billets, angles, channels, and other readily obtainable material. In many cases the steel plate or slab construction is preferable to the use of forgings or gray iron or other castings, mechanical difficulties in shaping the former economically and accurately often having been the only serious deterrent to their use. The employment of oxy-acetylene cutting has now made it possible to handle this work speedily and with economy. The use of steel plate or steel slabs rather than special castings or forgings often makes possible the production of lighter, stronger machines. The cost is generally less than when special castings must be made, and in all cases the employment of stock material, by eliminating the delay incident to the production of special parts, cuts to a minimum the time necessary for production.

When a number of machines are to be built to specification, members shaped with the cutting blowpipe may be used to additional advantage. The cutting of the parts for a special machine may progress with the assembling, so that last-minute changes in design will not make it necessary to scrap costly parts; furthermore, such changes will not involve excessive delay for the preparation of the parts needed. In addition to cutting plate and shapes to size, and preparing frames, braces and supports, the oxy-acetylene cutting blowpipe is useful for cutting bolt and rivet holes, and slots and openings of all sizes and shapes. Straight or irregular cuts may be made with equal facility wherever needed, and at a saving in time.

On heavy material particularly, the savings in cost may be great. For one thing, the portability of the oxy-acetylene cutting outfit makes the transportation of the work from one part of the plant to another for shaping unnecessary. Then, too, billets, blooms, and slabs of such size as to make their handling with shears or saws difficult can be cut true to size easily and quickly with the blowpipe. This work may be done at or near the point of assembly, thus saving time and cost by reducing handling and transportation to a minimum.

Lately the practice has been finding favor, where important forgings are being cut to shape with the oxy-acetylene blowpipe, of preceding the cutting by preheating of the forging to a dull red if the depth of cut is more than five or six inches. Particularly in heavy sections of material of high carbon content this preheating will tend to eliminate strains and prevent checking. The cutting should be followed by normalizing the steel at a temperature of approximately 1650 degrees F., which will overcome any strains present after the cutting and put the grain structure of the metal in the best condition for service.

When time is an important factor, the use of forgings or castings may not be practical. Material is always available, however, from which machine parts may be cut, reducing the time necessary to produce special parts by other methods. Many manufacturers have found it much cheaper to prepare the parts required by oxy-acetylene cutting as they are needed than to carry a supply of special castings in stock. In experimental work this method of cutting metals has found an important field of usefulness. Full-size or part-size working models may be made without difficulty, eliminating the delay incident to the making of templets,

castings, or pieces machined to shape and dimension. Changes in design suggested while the model is in the process of manufacture can be incorporated in the work at a minimum of delay, inconvenience, and cost.

When the oxy-acetylene cutting process is employed, it is generally unnecessary to provide specially designed mechanical equipment to form parts for extraordinarily large or otherwise unusual machinery. In practically every case, the cutting torch is all that is necessary to fabricate the parts, and a large investment in special and probably little used equipment is not required. The advantages of the use of oxy-acetylene cutting in forming new material are no more important than in working used and reclaimed metal. Often parts of obsolete equipment can be salvaged and, after being trimmed to the proper size and shape, employed in the making of new machinery. The possible reductions in cost through this application are evident. These may be particularly important when the oxy-acetylene welding blowpipe is employed to supplement the work of the cutting torch.

The possibilities of this application are almost limitless. In recent instances cases have been noted where machine guards, stair stringers, railings, passageway floors, small tanks for fuels or lubricants, idlers and guide rolls for belts, drip pans, and many other pieces of equipment have been made at very low cost from old pieces of angle and channel iron, steel sheet and plate, and wrought iron or steel pipe. In every case the material was salvaged and cut to size and shape with the cutting blowpipe; and in most cases it was formed by the oxy-acetylene welding process.

The large number of operations for which machinery builders are employing the oxy-acetylene cutting process illustrate the importance that has been attained by this method of cutting metals in the machinery industry. Recently a manufacturer of heavy machinery received an order that included thirty-two steel mill roll housings. The customer for whom the roll housings were to be made demanded rush delivery, and the time necessary to produce and deliver the forged housings would have made the fulfillment of the customer's demands impossible, had no other means been available for the production of the parts for which forgings had always been used.

In the emergency, however, the idea of cutting the parts from steel billets with the oxy-acetylene blowpipe was presented. (See Figs. 1 and 2.) It was tried out on a part of the order, with such immediate success that the entire order was completed with oxy-acetylene cut parts, and this cutting process was adopted by the management as standard practice for this and all similar work of the future. An accurate check on the costs of cutting these members from slabs 3½ inches thick demonstrated that the oxy-acetylene cutting process resulted in a substantial reduction. The cutting blowpipe used in this instance was mechanically guided in a so-called straight-line cutting machine, as shown in Fig. 1.

Straight-line cutting machines are also being used to advantage in plants where follower blocks for railroad cars are cut from steel slabs. In one plant a heavy shear was formerly used, and the blocks rejected as above or below the required limits ran up to 18 per cent of the total number cut. The principal difficulty encountered was the tendency to make a cut which, on the very heavy material used, either did not start true or finish square. In this plant the use of the oxy-acetylene cutting blowpipe reduced the proportion of rejections to less than 1 per cent of the total number of blocks cut. At another plant saws were being used to cut the follower blocks. The chief disadvantages of this method were the time necessary for each individual cut, and the expense entailed in replacing saw teeth ruined by the heavy work. The cutting of a single block with the saw required an average of twenty minutes. This time was reduced, by the use of the oxy-acetylene process, to an average of less than one minute and thirty seconds.

An instance of the use of oxy-acetylene cutting for special work is presented by a manufacturer of railroad contracting equipment whose products are largely made to customers' special requirements. The oxy-acetylene blowpipe makes possible the production of such equipment without delay for special parts, and minimizes the cost of effecting changes in design from corrections or alterations in the specifications. The railroad ditcher shown in Fig. 3 was built largely by means of oxy-acetylene cutting. The spreader arms were cut to size from tank steel sheets ⅝ inch thick. Manganese steel castings were cut to fit the irregular lower edges of the spreader arms. Channels, shapes, and angles were cut to size and shape for use as supports and manipulating mechanism. Likewise, the frames for the plows were cut to size and the car truck bolster and various supporting bars were prepared by cutting with the oxy-acetylene blowpipe. All of these operations resulted in savings over the methods formerly employed.

A manufacturer of press brakes uses the oxy-acetylene process for similar operations. In this instance 2½-inch

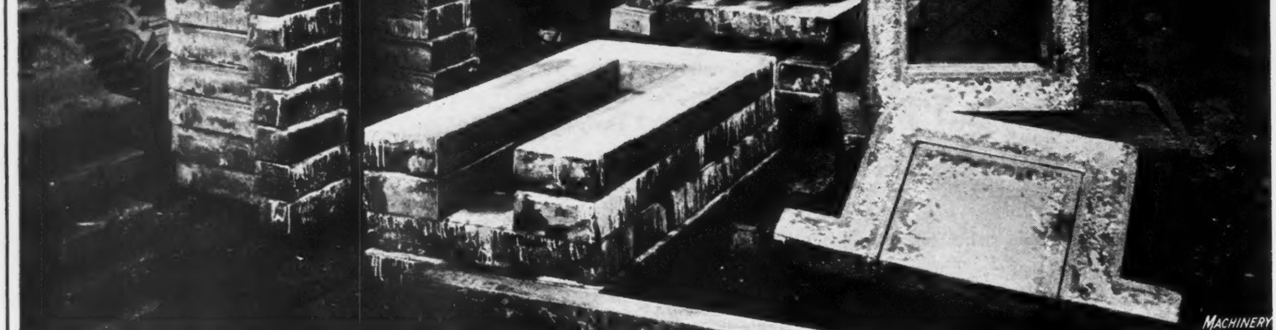


Fig. 2. Pile of Roll Housings cut from Steel Slabs by the Use of the Machine shown in Fig. 1

machinery steel plate is cut to size and shape. Here the oxy-acetylene cutting process is employed primarily to provide stronger parts than the special castings ordinarily used. The manufacturer found, however, that in addition to accomplishing the object he had in view, the use of stock plate cut to size was less expensive than the use of castings. The time saved in this instance in the regular production of the press brakes was also of great importance, since immediate delivery of the machinery plate could be had in the quantity required. This company builds special machines and, although there are nearly always eight or ten machines in process of construction, there are seldom two of the same size or design. The sizes of the parts necessary vary greatly with each job and each kind and style of press. The wide range of adaptability of the oxy-acetylene cutting blowpipe aids this company materially in keeping the production costs at a minimum.

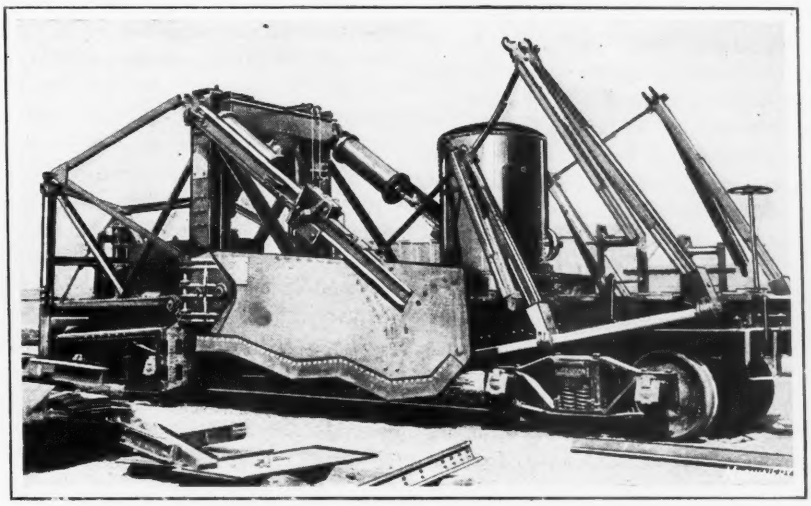


Fig. 3. Railroad Ditcher fabricated by Oxy-acetylene Cutting

In this plant the material for each machine is delivered to the point at which the machine is to be completely built. As the assembling progresses, special parts and pieces are cut to size and fitted to the work. No finishing of the parts prepared in this way is necessary, as the oxy-acetylene cuts are usually well within the limits of accuracy that are demanded.

These cited uses in the machinery trade illustrate some of the advantages of metal cutting by the oxy-acetylene process for the classes of work mentioned. There is no doubt that many others in the trade will be able to adapt the oxy-acetylene process to their own production work in ways similar to those described.

* * *

MEETING OF THE AUTOMOTIVE ENGINEERS

The summer meeting of the Society of Automotive Engineers was held at Spring Lake, N. J., June 19 to 23. The convention was opened by a meeting of the Standards Committee, acting upon several important recommendations, which are reported in full in the June number of the Journal of the society. The technical sessions covered a number of subjects of interest to automobile engineers. James E. Hale read a paper on large-section air cushion tires, discussing the effect of large tires on steering, skidding, and traction. He also dealt with the serviceability, cost, power consumption, and cushioning effect. Another session was devoted to four-wheel brakes. Four types of brakes were described by their makers: The Lockheed, hydraulic, Duesenberg hydraulic, U. S. Axle mechanical, and Renault mechanical. A general discussion was entered into in connection with this session on the advantages and the disadvantages of four-wheel brakes.

At a later session, R. N. Falge read a paper on head lamp glare, and Dr. C. H. Sharp, chairman of the Committee on Motor Vehicle Lighting of the Illuminating Engineering Society, discussed anti-glare legislation. The latest results of the society's fuel research test were presented by W. S. James and Dr. H. C. Dickinson. Professor G. B. Upton of Cornell University read a paper on the effect of spark advance on engine performance.

ALUMINUM SOLDERS

In a circular of the Bureau of Standards, it is pointed out that all metals or combinations of metals used for aluminum soldering are electrolytically electro-positive to aluminum. A soldered joint is therefore rapidly attacked when exposed to moisture and disintegrated. There is no solder for aluminum of which this is not true. Joints should therefore never be made by soldering, unless they are to be protected against corrosion by a paint or varnish, or unless they are quite heavy, such as repairs in castings, where corrosion and disintegration of the joint near the exposed surface would be of little consequence.

Solders are best applied without a flux or by using paraffin as a flux, after preliminary cleaning and tinning of the surfaces to be soldered. The composition of the solder may be varied within wide limits. It should consist of a tin base with the addition of zinc or of both zinc and aluminum, the chief function of which is to produce a semi-fluid mixture within the range of soldering temperatures.

Suggested Ranges of Composition

Tin-zinc Solders

Zinc, per cent	15 to 50
Tin	Remainder

Tin-zinc-aluminum Solders

Zinc, per cent	8 to 15
Aluminum, per cent	5 to 12
Tin	Remainder

The higher the temperature at which the "tinning" is done, the better the adhesion of the tinned layer. By using the higher values of the recommended zinc and aluminum percentages given, the solder will be too stiff at lower temperatures to solder readily, and the workman will be obliged to use a higher temperature, thus obtaining a better joint. A perfect union between solder and aluminum is very difficult to obtain. The joint between previously tinned surfaces may be made by ordinary methods and with ordinary soft solder. Only the "tinning" mixture need be special for aluminum. There is no reason why a good solder for aluminum need be brittle, as several commercial varieties are, and it is very undesirable that it should be.

* * *

The American Welding Society has just issued an outline of a course for the training of oxy-acetylene welders. This report was prepared by a committee and combines the experience of experts of the Federal Board of Vocational Education, the American Welding Society, and the National Research Council. For the information of the person who is selecting candidates, the text includes a discussion of the qualifications that the candidates for training should possess. For the information of the instructor, the text includes the fundamentals in gas welding, together with a detailed statement of content, classified under type welding jobs arranged in the order of difficulty. Copies may be obtained from the American Welding Society, 29 W. 39th St., New York City.

JULY, 1923

MACHINERY

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THE INCREASING USE OF PRESSED STEEL

During the business depression from which the metal-working industries are rapidly emerging, the shops making stampings and pressed-steel parts have probably been the busiest—those engaged in automobile construction excepted. The rapidity with which pressed-steel parts can be made, and their relative cheapness when produced in quantities, are two important factors in their favor, compared with parts produced by other methods.

At present, a large new field for the use of pressed-steel parts is being developed. In many instances it has been found advantageous to replace gray iron castings with pressed-steel parts. Covers, frames, boxes and other metal parts that can be made conveniently from pressed steel are lighter, stronger and cheaper. An iron casting must be reasonably thick to permit molding and afford sufficient strength. The pressed-steel part can be made much thinner, and yet is stronger because of the greater strength of steel. It does not have the brittleness of cast iron, and can stand a remarkable amount of abuse without damage. Being thinner, the steel part is also lighter, an important consideration with present high freight rates, when the manufactured articles have to be shipped long distances. The only serious factor in this process is the cost of the dies, necessitating a considerable production in order to absorb the first cost.

Some examples of savings may be of interest: Cast-iron covers for instrument boxes, cleaned and ready for use, have been produced for about $4 apiece. Made from pressed steel, these covers cost only 85 cents, not counting the cost of the dies. The dies cost $1200. If a thousand covers were produced, the total cost per piece would be $2.05, including the die cost, the saving being $1.95 per cover. After the die cost has been absorbed, the saving per cover is $3.15.

Tool boxes formerly made by hand from sheet steel cost $7 apiece; the pressed-steel boxes cost $3 apiece. The dies in this case cost $2500. If a thousand boxes were made, the tool cost per box would be $2.50 and the total cost, $5.50, or a saving of $1.50 per box. After the die cost has been absorbed by the first thousand boxes, the saving per box for those made in excess of one thousand would be $4 apiece. These figures are given to indicate possible economies, and to point out the importance of investigating this method of manufacture. Sometimes, parts that cannot be made in one piece by the power press method can be produced in two pieces and welded together at a considerable saving over a casting.

At times, strength and lightness, and not saving in cost, may be the important factors; but in either case the possibilities of pressed steel are well worth investigating.

* * *

THE EFFECT OF LABOR-SAVING MACHINERY ON WAGES

When power looms were introduced in the textile industry of Great Britain not quite 150 years ago, labor fought bitterly the introduction of this mechanical means for supplanting the work of human hands. And for a century and a half labor has fought almost every mechanical advance, regarding them as steps toward the time when machines would supplant men and when there would be no manual labor to be done. But in actual practice the result has been entirely different. Never before has automatic machinery been employed to the extent it now is in this country. Nowhere else is it possible to perform so much work with so little human exertion as in the shops and factories of the United States, where automatic machinery is developed to the highest degree. Yet in this country the highest wages in the world prevail, and with all this automatic machinery there is such a shortage of labor that many plants are unable to operate to capacity because there are more jobs than workmen. Automatic machinery does not deprive labor of jobs—it creates jobs, and by reducing the cost of the product brings within the reach of the masses necessities and luxuries unknown to the workers of other countries.

The practical effect of labor-saving machinery on wages is nowhere more plainly visible than in the highly specialized automobile plants, where we find automatic machinery used to the greatest extent. There special single-purpose machines turn out their product with incredible rapidity, and comparatively unskilled operators run them. In fact, unskilled men in the automobile industry are often paid higher wages than many of the skilled men in other metal-working trades, because the use of automatic machinery makes it possible to produce work in such quantities that high wages are warranted. All classes have benefited by the development of labor-saving machinery; but most of all the masses of the people have benefited, and this is as it should be.

* * *

THE COMMERCIAL VALUE OF PATENTS

Many inventors are inclined to overestimate the commercial value of their patented inventions. They often assume that with the issue of the patent all obstacles on the road to fortune have been overcome, and take little account of the work to be done to make the new device commercially successful. They do not realize that often fully as much depends upon the manufacturing and marketing methods applied to the new enterprise, as upon the merits of the device itself.

Many patented inventions of great merit have failed of commercial success because the necessary business ability and direction have been lacking. On the other hand, many articles of only mediocre merit have become highly successful because they have been ably developed, manufactured and marketed. This does not mean that merit in an invention is not of commercial value; it means that something more than a patent issued at Washington is required to establish that value commercially. The business ability that utilizes a valuable patent as the foundation for a prosperous industrial enterprise, is often fully as responsible for the success of the business as the invention itself.

Yet patent protection is frequently a valuable aid in starting a new enterprise. Assuming that the patent is reasonably basic, it permits a new business to get under way without too severe competition; but as the business acquires strength, it needs less and less to rely on the protection afforded by patents. Many of the great manufacturing and business firms that now dominate their field have seen their original patents expire without jeopardizing their commercial standing. Their organization, production and selling methods, their experience in a specialized field, and the ability that originally built or continued the business, are now the principal factors of success, although they are constantly striving to cover with patents valuable improvements that their experience has enabled them to develop.

Ten Years of Cooperative Education

By HERBERT D. CASEY, Springfield, Vt.

COOPERATIVE education is an attempt to combine theory and practice in a single course. The work in the shop is so interwoven with school work that while the student is working on a machine he is also studying its mechanical principles in a school suited to his needs. The town of Springfield, Vt., is admirably adapted for such training. With a population only a little in excess of 7000, it has six machine shops, two foundries, and a shoddy mill. The manufacturers of the town have steadily and enthusiastically supported this plan, and without this support the course would have been impossible.

After careful investigation by a group of school officials and a committee of manufacturers, the cooperative course was organized as a department of the Springfield public schools in 1913. Governor James Hartness of the Jones & Lamson Machine Co., and E. R. Fellows of the Fellows Gear Shaper Co., took an active interest in the work. John M. Pierce is director of the course at the present time, and under his management it is steadily growing in spite of depressed industrial conditions.

The boys enter the course at the beginning of the second year of high school, at an average age of approximately fifteen years. Previous to entering in the fall they spend the summer in the various shops to which they have been assigned. At the end of the summer, if the shop men are satisfied with their work and the boys still feel that they wish to go ahead, their parents sign a contract agreeing to keep them in the course for three years. While in the shops, they are under the direct supervision and management of the shop officials, and the director of the course at the school has only advisory relations with the foremen. The boys observe the same hours in the shops and are under the same working conditions as the men. One of the important things that differentiate this course from the ordinary trade school is the shop atmosphere. The work they do is real work, and must meet commercial requirements. The competitive basis of factory work is emphasized, and the relation of cost to output is discussed with the students. Everyday economics are thus combined with actual shop work. The atmosphere is exacting and business-like, and this is not the least valuable part of the course.

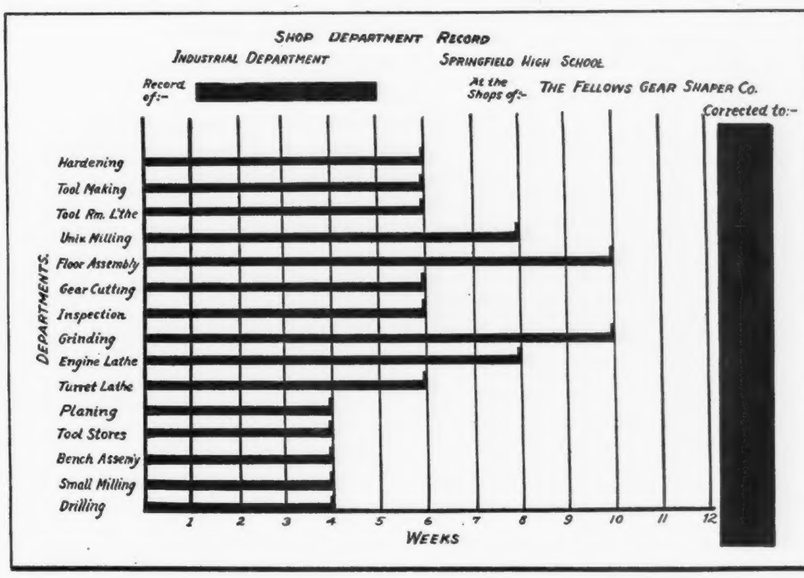


Fig. 1. Shop Department Record, showing graphically the Work completed by a Student in Each Department

Work in the shop is much more than a job. It is a practical school in mechanical problems. The officials give careful attention to the boys, correcting and encouraging them where needed. The course is carefully graded, beginning with simple machines, passing through the various departments, and completing the boy's mechanical experience in toolmaking and experimental work. A blueprint record sheet is kept for each of the students, showing the time devoted to the different processes. This schedule is completed early enough in the course to allow for extra training in the line in which each one has shown the most skill, because, after his "exploratory" work he is allowed to specialize. At the end of each fortnight every boy makes out a report of what he has done and gives it to the director. These reports are used in round-table discussions later in the school room classes.

The plan provides for dividing each of the three classes into two groups, as nearly equal as possible. One group of each class spends two weeks in the shop and the other group two weeks in the school. At the end of the fortnight these groups change places, and the work in each group is repeated.

The following is the program of studies: First year: Any regular high-school course. Second year: History, English, mechanical drawing, algebra, mechanisms, physics. Third year: Physics and chemistry, mechanisms, algebra and geometry, American history, mechanical drawing and English. Fourth year: Mechanisms, history, economics, mechanical drawing, mathematics, and English.

While the boys are working in the shops they receive pay ranging from 15 to 32 cents an hour, depending on the quality and quantity of work and the time the boy has spent in the course. Here, again, is a practical application of the economic law that quality and quantity determine earnings. During the three years these earnings amount to from $900 to $1000. In addition to this, the shops grant a bonus of $100 to each boy completing the course. The graduate, then, completes his four-year course in the high school with a fair knowledge of machine tool work, and the tidy sum of about $1000 which he has earned. He also has a definite knowledge of his abilities in a given field and a purpose to begin work at once.

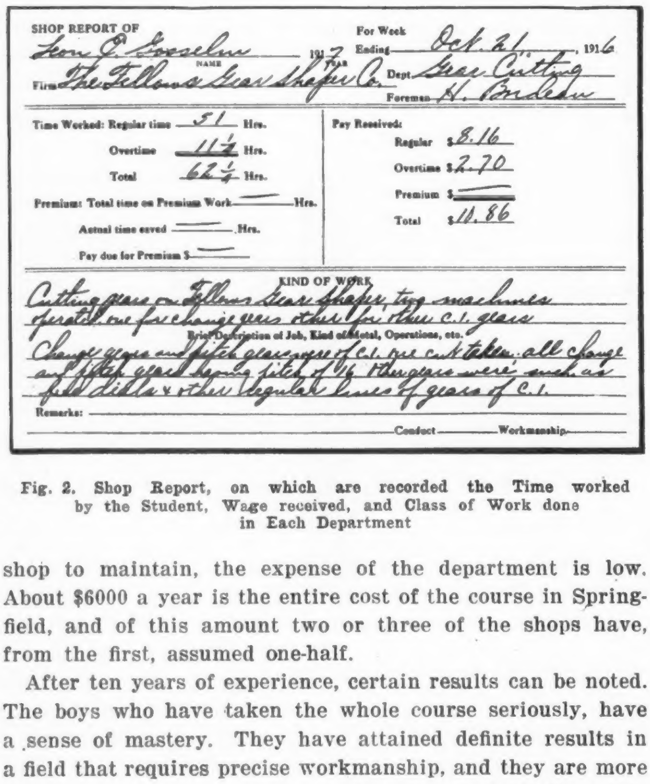
He is not perplexed with questions such as "What am I to do now?" or bothered with "dead end" and "blind alley" jobs. If the boy wishes to go further with studies, he is free to do so, although in order to enter college he generally has to make up foreign languages. The Northeastern College, the University of Cincinnati, and the University of Vermont have received graduates from Springfield into their engineering courses, where they have graduated with engineering degrees. One of the companies has just completed an arrangement with the Northeastern College in Boston, whereby two boys are received on an alternating five-week basis between the shop and the college. Those responsible

for the plan are not without hope that it may be the beginning of a new practice in engineering education in New England.

At the peak of the war rush, sixty-four boys were enrolled in the course. About forty-five are now taking the course, and the prospects are good for a greater number during the coming year. This is the tenth year that the course has been in operation, and seven classes have been graduated with a total number of fifty-seven completing the course. Of these, twenty-three are now employed in shop work; fifteen in drafting-room, office or on the road for machine-building concerns; five are engaged in automobile repair and driving; seven are in college; and one is teaching.

The Purpose of the Course

This is not a course for slow or retarded pupils. The student should be as keen and alert in order to make a success in this as in any other calling. Sometimes it happens that boys who have not done very well in other academic branches are awakened by the concrete problems of the shop and do excellent work; but, primarily, this is technical work brought into the high school, and to obtain the best results, the best material is necessary. As there is no laboratory or machine


SHOP REPORT OF Leon O. Gosselin NAME 1917 Year

Firm The Fellows Gear Shaper Co.

For Week Ending Oct. 21, 1916

Dept. Gear Cutting

Foreman H. Bordeau

Time Worked: Regular time 51 Hrs.

Overtime 11½ Hrs.

Total 62½ Hrs.

Premium: Total time on Premium Work — Hrs.

Actual time saved — Hrs.

Pay due for Premium $ —

Pay Received:

Regular $8.16

Overtime $2.70

Premium $ —

Total $10.86

KIND OF WORK

Cutting gears on Fellows Gear Shaper, two machines operated one for change gears other for other C.I. gears

Brief Description of Job, Kind of Metal, Operations, etc.

Change gears and pitch gears were of C.I. one cut taken. all change and pitch gears having pitch of 16. Other gears were such as field disks & other regular lines of gears of C.I.

Remarks:

Conduct Workmanship

Fig. 2. Shop Report, on which are recorded the Time worked by the Student, Wage received, and Class of Work done in Each Department

shop to maintain, the expense of the department is low. About $6000 a year is the entire cost of the course in Springfield, and of this amount two or three of the shops have, from the first, assumed one-half.

After ten years of experience, certain results can be noted. The boys who have taken the whole course seriously, have a sense of mastery. They have attained definite results in a field that requires precise workmanship, and they are more sure of themselves than those who have not had this training. Association with men and with real men's problems gives them a maturity of judgment and a fixity of purpose not generally found in academic students of their age.

Another good feature of the course is the notable change in the attitude of the "Co-ops" toward school and life in general. The question of what to do for a living and what is his place in life are questions of greater interest to the boys after working in the shops. They realize more and more fully what it means to earn a living, and how much easier it becomes with an education. Having earned money in the shops by real work, they realize the value of a dollar more than ever before.

The department has about an average rank in scholarship. It carries a heavy line of studies with only half time to devote to it. If another year could be given to the course—two full years in high school—it would be beneficial. As it is, the boys of this department take a fair share of school honors, and some of them have made a brilliant record at college. Literature, history, and economics are stressed in the course, which supplies the cultural element in so far as books can do so. The fundamental idea of schools is to train the learner to think, and correlated shop work is a constant stimulus to thought processes. Ideas must stand the acid test of workability.

* * *

WORK DONE BY THE GEAR MANUFACTURERS' STANDARDIZATION COMMITTEES

A considerable amount of standardization work is being done by the various sub-committees on standardization appointed by the American Gear Manufacturers' Association, with headquarters at 2443 Prospect Ave., Cleveland, Ohio. B. F. Waterman of the Brown & Sharpe Mfg. Co., Providence, R. I., is chairman of the general standardization committee of the association, and communications relating to gear standardization may be addressed to him.

A brief resumé of the work of the different standardization committees shows that the following items are now being considered: Spur gear nomenclature; rules for the strength of spur gearing; standards for bevel pinions of ten teeth or less; bevel gear nomenclature; proportions of worms and worm-wheels for single- double-, triple-, and quadruple-threaded worms; rules for calculating the proportions of worm-wheels for existing hobs; standards for roller chains, adopted in conjunction with committees of the American Society of Mechanical Engineers and the Society of Automotive Engineers; means for inspecting gears for noise; recommendations for the treatment of various gear steels; the testing of steels by the spark test; recommendations relating to the use of standard gear hobs for cutting herringbone gears; standards for electrical railway gear pinions; standard forged steel gear blanks for electric railway service; standards for keyways; nomenclature for differential gearing, to be adopted in conjunction with the Society of Automotive Engineers; and a standard stub tooth form.

* * *

LARGE-SCALE RAILWAY ELECTRIFICATION

In order to increase the traffic capacity and to secure operating economies, the Virginian Railway has decided to electrify 213 miles of its track in Virginia and West Virginia, involving an expenditure of $15,000,000. The Westinghouse Electric & Mfg. Co. has been awarded the contract for the electrical equipment, which is said to form the largest railroad electrification contract ever placed. The division of the railroad to be electrified crosses the Allegheny Mountains. The electric locomotives will develop 20,000 horsepower, and will haul trains of 9000 tons up the grades of the road at a rate of fourteen miles per hour. Provisions have been made for increasing this power in the future so that 12,000-ton trains can be handled at the same speed. The power for the operation will be supplied by a 90,000-horsepower hydro-electric generating plant, supplying 88,000-volt current to the main transmission line. This high-voltage current is stepped down to 11,000 volts by transformer stations, and thence it enters the trolley wire from which the locomotives draw their power.

* * *

For some time past a study has been in progress in the metallurgical laboratories of the Bureau of Standards on the properties of various grades of boiler plate through a temperature range of from 20 to 465 degrees C. (68 to 869 degrees F.) The results of this work have been published in Technologic Paper No. 219, which describes the special apparatus employed for making high-temperature tensile tests and the differences in behavior of the steel that were noted in the temperature range specified.

Requirements in Cutting off Metal

By M. E. ERSKINE, President, Racine Tool & Machine Co., Racine, Wis.

IT seems that at present further development in cutting off metals by the power hacksaw machine is limited by the quality of the hacksaw blade, and that the next step in the development of cutting-off equipment must come from the hacksaw blade manufacturers. In any discussion of metal sawing, the first consideration is the speed at which the blade should travel to secure the best results. For all practical purposes, the writer is confident that three speed changes are ample for cutting 90 per cent of all the metals ordinarily cut on a hacksaw machine. These metals may be arranged under three heads as follows:

1. Mild steel and iron bar stock, and all metals of equal or less degree of hardness.
2. Steel over 0.35 per cent carbon, annealed tool steel, and tough materials such as nickel steel and bronze.
3. Unannealed tool steel and all very hard metals.

With a machine of modern design, having a 6-inch stroke, these classes of metals should be cut at about 125, 90, and 60 cutting strokes per minute, respectively. Faster cutting speeds may be possible, but when reasonable economy in blades is considered, these speeds are the most practical.

Pressure on Blade while Cutting

The average power hacksaw machine of today is arranged so that a definite limit is set on the amount of pressure to which the blade may be subjected. The pressure is regulated by weights acting through gravity, by spring pressure, or by what is known as "force feed." Unfortunately, a large number of machines do not provide any ready means for determining the amount of pressure applied to the blade at any given time; it is, however, preferable to have the pressure definitely known and limited, as the teeth of any blade will quickly give way under severe cutting pressure. The width or gage of the blade is of little consequence under these conditions, because it is the cutting edge or point of the teeth that breaks down. Metals in the first class mentioned, for average conditions, require that the full limit of pressure be applied; in the second class from one-half to three-fourths of the full pressure may be used; and in the third class, the minimum pressure that the design of the machine permits, should be used.

These general rules must not be followed too literally. Common sense plays a large part in obtaining the best results in the use of cutting-off machines. The rules given for speed and pressure are for average conditions. When fast production is required, regardless of cost, greater pressure or higher speeds may be used at the expense of blades and accuracy. Furthermore, a new blade requires less pressure to cut a given amount of metal than a used blade. As the blade loses its sharpness, the pressure should be increased; and as the pressure is increased, the faster will be the wear on the teeth. This leads to the conclusion that it is a waste of time to use a blade after it has ceased to cut freely. There is a very definite point in the life of a blade when it ceases to cut freely and starts to "ride" over the material. This point is readily determined by any operator familiar with metal-cutting, and judgment as to when this point is reached counts for more than any general rule.

Effect of the Design of the Hacksaw Machine

The manner in which the blade is applied to the metal by means of the machine has a great deal to do with the maximum efficiency in cutting off metals and the life of the blades. Machines without means of lifting the blades on the non-cutting stroke are still in use in many places. This is the main reason for looking upon the hacksaw machine as the discredited member of the machine tool family, and the manufacturers of modern high-speed power hacksaw machines must live down this reputation and educate users to an understanding of the possibilities of the modern machine.

Everyone will agree that the hacksaw blade is made to cut one way only, and that it ought to be applied in such a way that it will clear itself of chips on every stroke. When it is allowed to drag back, the chips naturally clog in the teeth and are pulverized into an abrasive which quickly wears away the set of the teeth and dulls the cutting edges. It is safe to say that one back stroke, dragging the teeth on the metal, dulls the blade more than ten cutting strokes. Therefore, the important point in any machine of this type is the lift on the non-cutting stroke. The lift should be mechanically positive, and should work unfailingly under all pressures.

A simple test for determining whether the saw is lifted free of the work on the return stroke is to operate the machine and notice whether all the chips are deposited on one side of the cut. If the chips are divided between both sides of the cut, it is evident that there is not sufficient lift of the blade on the non-cutting stroke. Another test is to examine the chips under a magnifying glass and determine whether they are long and curled up, as if they had been cut in a lathe, or whether they have been broken up or ground into powder. The latter test can naturally be made only on soft steels or free-cutting materials.

Savings Effected by Correct Means for Cutting off Metals

The average shopman does not realize the great savings that are possible in cutting off metals. The abuse of hacksaw machines constitutes one of the greatest hidden sources of waste in any metal-working shop. Suppose, for example, that it is required to cut off 3-inch cold-rolled shafting all day long. If the machine is designed to lift the saw properly from the cut on the back stroke, and pressure is correctly applied, one blade should last a full day of ten hours, cutting at the speeds and pressures specified. If the machine is out of adjustment so that the lift on the non-cutting stroke is inoperative, or if the machine is designed without a lift, the blade would last only one-tenth of the time mentioned. This means a saving by the first machine of ten to one on blades, or, expressed in dollars and cents, about $1.50 per day or $450 a year on one machine alone. In addition, production is slow and crooked cuts are generally the result of using a machine which is continually wearing out blades.

Let us take another example: In a certain tool steel warehouse, an antiquated machine is in operation, which cuts all day long at 60 strokes per minute. The blade drags back and forth. The cuts run out from 1/8 to 1/4 inch, owing to the fact that the blade has lost its set during a few dragging back strokes. On an average, this machine will cut 1/2 inch per minute of solid metal, or 30 inches per hour. It will waste from 1/8 to 1/4 pounds of solid metal per minute by cutting crooked which requires that the ends be trued up later on. With tool steel at 20 cents per pound, this machine will waste $1.50 to $3 worth of stock per hour in cutting only 30 inches of stock. The modern high-speed

power hacksaw will cut an inch a minute easily, and should be able to cut any number of pieces with a limit of plus or minus 0.010 inch. In that case there should be less than 20 cents waste of metal per hour, and the production would be doubled.

Increasing Production

The examples given in the foregoing show, first, the savings possible in blades; and, second, the savings possible in material. It remains to give a typical example of increased production. The average old-style machine in use in many shops, at 60 strokes per minute will cut off, at best, one piece of one-inch square stock every two minutes, or thirty per hour. Three hundred pieces per day of ten hours might be possible, but improbable. A modern high-speed machine does the same amount of work in five hours, and the saving in labor cost will amount to at least \$2 or \$3 per day at present wages. At the present time it is estimated that about 50 per cent of the machines in operation are of the old type, that increases the production costs as indicated. The average small shop, as well as many of the larger ones, operate hacksaw machines that do not have the modern improvements that make for economy and accuracy. Most of these shops would save the price of a modern high-speed machine in a short time.

It is astonishing how difficult it is to convince many good mechanics that both rapid and quite accurate work is now possible on the modern hacksaw machine. The following examples will illustrate what can be accomplished. On a modern machine, in which are embodied the principles outlined at the beginning of this article, one blade will cut off 600 pieces of one-inch square or round mild steel in one day, operating at high speed and full pressure. This represents the cutting of 50 feet of solid metal. One blade will cut off twenty-five pieces of 5-inch cold-rolled shafting with limits of plus or minus 0.010 inch, and with a difference of only five minutes in cutting time per piece between the first piece and the last.

As for cutting time it is reasonable to allow one square inch per minute on all mild steels. In estimating the average cutting time of a round bar, therefore, if the square of the diameter is multiplied by 0.7854, the result will give the possible cutting time in minutes. In the case of flat stock, the area in inches will also indicate the approximate cutting time. However, this rule is merely given as a convenient guide, and carefully conducted tests may show that better results can be obtained under favorable conditions.

It has not been the author's intention to present a technical article on metal-cutting, but to give a few practical illustrations of work actually performed every day. It would not be practicable to produce complete tables for metal-cutting speeds for every class of material, because actual results are dependent upon too many conditions which cannot be directly controlled; for example, the blades may vary in uniformity of hardness and in the set of the teeth; the stock may vary inch by inch in hardness, and the machines may vary widely in cutting capacity.

In order to train the user to recognize the difference between the modern power hacksaw and the older types, many manufacturers have eliminated the use of the word "hacksaw machine" in reference to their product, and are referring to their machines as metal cutting-off machines. It is well to note this distinction, and it is the part of wisdom to provide the best machine rather than the cheapest one for future use.

* * *

An indication of the fact that machinery manufacturers are making increasing use of the services offered by the Bureau of Foreign and Domestic Commerce is found in recently published figures of inquiries received by the bureau. During the period June 27, 1921 to July 1, 1922, 11,178 inquiries were received from machinery manufacturers, while from July 2, 1922 to May 26, 1923, 41,098 were received.

CUTTING OFF BAR STOCK AT A HIGH RATE OF SPEED

The cutting of heavy bar stock into pieces of the required length is an important operation in the manufacture of many products. The rate at which this operation is performed varies considerably in different plants, even in cases where cutting-off machines of the same kind are used under similar conditions. In this article, data are given on the results obtained in various plants in cutting off bars ranging from 2½ to 7 inches in diameter, on Gorton machines.

Cutting off Carbon Steel Bars

In the plant of one large steel company, seven cutting-off machines employed regularly in cutting off 3½-inch steel bars averaged 55 cuts per hour for each machine. The cutter travel was 50 feet per minute, and two bars were cut off at a time. The carbon content of the bars was 0.50 per cent, and the manganese content 0.76 per cent. In another plant of the same company, 41 cuts per hour were made by one machine on 4⅛-inch bar stock in the initial tests, but this rate could not be regularly maintained owing to the crooked condition of the bars and the lack of proper facilities for handling the stock.

In still another plant four machines were regularly operated at the rate of 16 cuts per hour, on each machine, cutting 6⅜-inch diameter shell steel of 0.50 per cent carbon with a high manganese content. A representative of the manufacturer of these machines obtained a production of 240 cuts per 10 hours in a test made under unfavorable conditions.

Cutting off Brass Bar Stock

During a test at the plant of a large brass concern, 5-inch common round leaded brass bars were cut off in 12 seconds. The time for cutting off a bar 6 inches in diameter of the same material was 20 seconds. These are actual cutting times and do not allow for handling the work. The regular production time for 7-inch stock in this plant was 70 cuts per hour. In another plant, common round leaded brass 7 inches in diameter was cut off in 9 seconds, actual cutting time. Naval bronze bars 7 inches in diameter required 15 seconds per cut.

Tests Made to Determine Practical Cutting-off Speeds

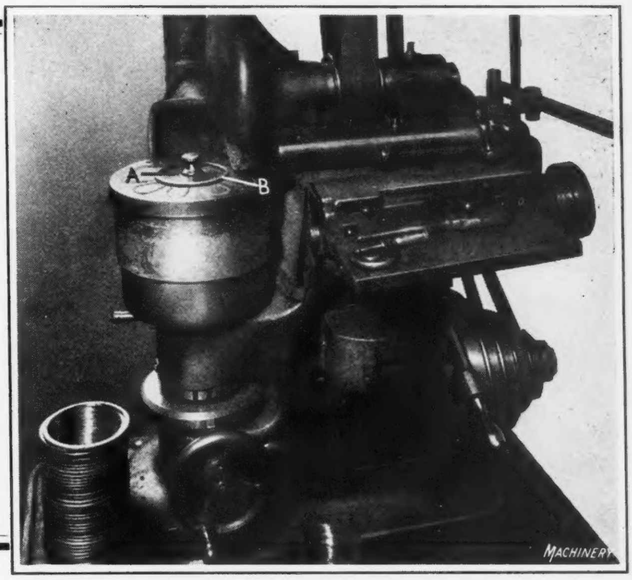
In a series of tests made by a large concern for the purpose of determining the most economical feeds for cutting off steel bars, it was found that 2½-inch bars having a carbon content of from 16 to 25 points could be cut off in 20 seconds. In this test, the cutter made 35 revolutions per minute, which gave a surface cutting speed of 91 feet per minute. The cutter feed was 6½ inches per minute. The total time for setting and cutting off the bar was 50 seconds. With the same cutter speed and a feed of 5 inches per minute, 3½-inch steel bars of 35-point carbon were cut off in 42 seconds; the total time for setting and cutting off being 77 seconds. The quickest time in which 4-inch stock was cut off was 35 seconds. With a cutter speed of 91 feet per minute, 6-inch round stock was cut off in 64 seconds.

As a result of these tests it was decided that 28 seconds was a good minimum time to allow for cutting off 2½-inch steel bars, 37 seconds for 3-inch bars, 52 seconds for 4-inch bars, 76 seconds for 5-inch bars, and 105 seconds for 6-inch bars. The machines used in all the cutting-off operations described in this article were made by the George Gorton Machine Co., Racine, Wis., using their internal-tooth type of saws. In special tests made at this company's plant to determine the strength of the saw teeth or cutters, a 6-inch 9-point carbon steel bar was cut off in exactly 40 seconds, with a feed of 9 inches per minute. In another test 1000 pieces of 3½-inch round steel stock were cut off in a day of 10 hours. In this test the stock was bundled, special jaws being employed to hold one bar directly above the other.

Machining "V-plex" Piston-rings

A Leak-proof Automotive Piston-ring and Tools and Methods Used in its Manufacture

By EDWARD K. HAMMOND



VARIOUS forms of leak-proof piston-rings have been developed to increase the efficiency of operation of automobile engines. In this article a brief description is given of the "V-plex" type made by the Krasberg Piston Ring Co., 536 Lake Shore Drive, Chicago, Ill., together with a detailed description of the successive machining operations performed on the ring members.

V-plex piston-rings consist of a central wedge-shaped ring and two outer so-called "pressure rings," which are assembled together to make a packing for one groove in the piston as shown in Fig. 1. The advantage claimed for a composite ring of this kind, as compared with the commonly used solid type of ring, is that it completely fills the groove in the piston and also expands to fit tightly against the wall of the cylinder, thus preventing leakage around the rings which wastes power and oil, causes spark plugs to become covered with soot, and allows carbon to be deposited in the cylinders.

It is claimed that the wedge-shaped center ring of the V-plex piston-ring forces the two outer rings firmly against the walls of the groove to form a complete seal; and as years of service wear down the edges of the ring members that fit snugly against the cylinder walls, the rings automatically compensate for this wear, so that there is no leakage between the cylinder wall and the outside of the rings. In assembling the three parts of a V-plex piston-ring into its groove, care should be taken to stagger the split ends of each ring, so that they are uniformly distributed around the circle.

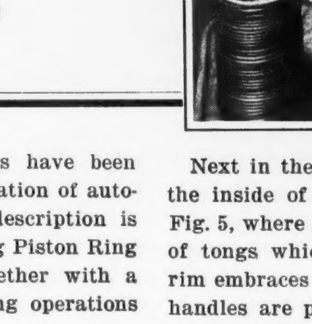


Fig. 1. Cross-section of "V-plex" Piston-ring

Preliminary Machining of Outer Rings

The outer members of the V-plex piston-rings are machined from individual castings. It is claimed that when this procedure is followed, the rings have more resiliency than those cut from the so-called "pot" casting, and as a result, are better adapted for the purpose intended. As the castings for the outer rings come to the machine shop, the first step is to face one side of each ring, which is done on a short-bed lathe built by the Porter-Cable Machine Co., of Syracuse, N. Y. As shown in Fig. 4, this machine is equipped with an air chuck operated by a pedal *A*, which provides for centering and clamping the work. This method of controlling the chuck leaves both of the operator's hands free for rapidly handling the small pieces of work, and is found to be the means of increasing production. The facing tool indicated at *B* is carried by a cam-actuated rocker-arm which swings the tool forward into position to feed it across the casting.

Next in the sequence of operations comes the snagging of the inside of the ring. This work is shown in process in Fig. 5, where it will be seen that the casting is held by a pair of tongs which are provided with a flexible rim *A*. This rim embraces the outside of the work, so that when the tong handles are pressed together, it grasps the casting. Inside the flexible rim there are three pins against which the previously faced surface is located, so that the ring is held perpendicular to the snagged inner surface. It will be apparent by reference to the illustration that a grinding wheel is used that is of a diameter slightly less than that of the ring. The inside diameter of the ring is ground to fit a plug gage.

Grinding the Sides of the Outer Rings

It is necessary to have both sides of the outer rings smooth and parallel, and in order to obtain this condition, each of the sides is ground. For this purpose, use is made of a Heald rotary surface grinder, as shown in the heading illustration. The machine is equipped with a magnetic chuck, at the center of which there is attached a disk *A* of slightly smaller diameter than the snagged inside diameter of the work. By simply dropping the ring *B* over this disk, a convenient method is provided for quickly locating the work, so that it may be rotated in constant contact with the grinding wheel.

After locating the work from the snagged inside diameter and chucking it from the faced side, the opposite side of the ring is ground down to a smooth surface. The object of this grinding operation is to obtain a uniformly smooth surface, and still leave as much of the hard outer scale as possible, because the scale is said to increase the resiliency of the ring. After this operation has been finished, the work is turned over to grind down the previously faced surface to the desired condition of smoothness and parallelism with the opposite side which has just been ground; also the ring must be reduced to the required thickness.

Turning the Outside Diameter

The inside diameter and the two side faces of the rings have now been finished, but it still remains to machine the outside diameter. For this purpose, the rings *A* are loaded on a mandrel of the form shown in Fig. 2. This is of simple design, consisting of a body with a shoulder *B* at one end and a removable collar *C* at the opposite end; which is held in place by four bolts. The piston-rings are located on the mandrel so that they come into contact with the

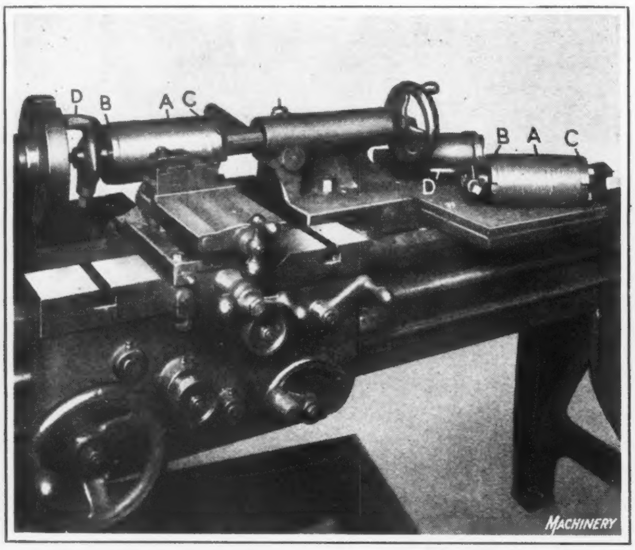


Fig. 2. Multiple Work-holding Arbor used for setting up a Load of Outside Rings on a Lathe for rough-turning the Outside Diameter

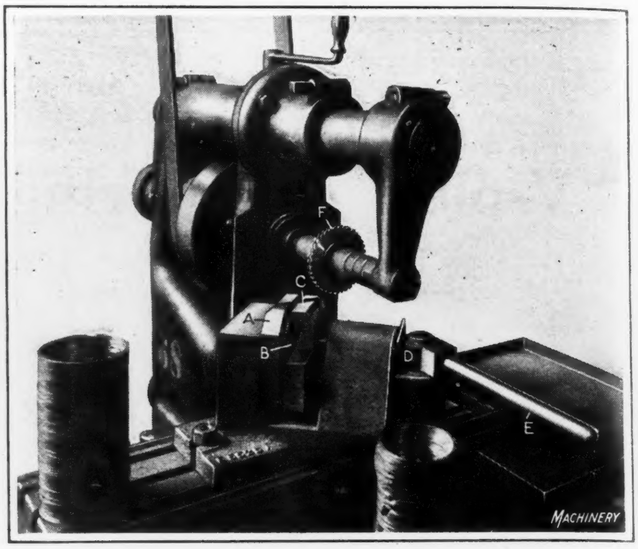


Fig. 3. Hand Milling Machine equipped with a Special Vise for holding the Outside Piston-rings while cutting a Diagonal Slot

shoulder, after which the removable collar is put into place and bolted to secure the work for turning. The mandrel is furnished with the usual driving dog *D* and holes to receive the lathe centers, so that it may be set up on an engine lathe, for turning the outside diameter of the entire load of rings, just as if they were a single piece of work.

Splitting the Rings and Finish-turning Outside Diameter

Fig. 3 illustrates a hand milling machine built by the Rockford Milling Machine Co., which is equipped with a hand-operated fixture that provides for clamping four of the piston-ring castings while they are being split. This fixture consists of a fixed jaw *A* with a pilot *B* for centering the rings from their snagged inside surface, and a movable jaw *C*, which is operated by a cam *D* and a hand-lever *E*. Four piston-ring castings are placed in position between the jaws, and then the hand lever is pulled over to close the clamp, after which the milling machine table is pulled over to feed the work under the two saw blades *F* which are spaced a sufficient distance apart so that they remove the required amount of metal from the wall of the piston-rings.

Next in the order of operations on the two outside members of V-plex piston-rings comes the finish-turning of the outside diameter. For this purpose, the rings are loaded on an arbor *A*, as shown in Fig. 6. It will be recalled that when the rings were rough-turned, they were located on the arbor (Fig. 2) from the snagged inside surface. This was sufficiently accurate for rough-turning, but for finish-turning, it is necessary to obtain a more precise setting. This is accomplished by the means shown in Fig. 6. As far as general appearance is concerned, it will be seen that the arbors *A* used for finish-turning are of similar design to those employed for roughing. The difference lies in the method of loading the piston-ring castings on the arbor.

Method of Holding the Work

For loading, the arbor is held vertically in a vise, so that the rings may be easily put into place, care being taken to stagger the splits around the arbor. The clamping collar *B* and nuts *C* are next put in place, but not tightened up. Then the arbor and work are transferred to a setting fixture *D*. The collars at *B* and *E* are of a slightly smaller diameter

Fig. 4. Short-bed Lathe equipped with Pedal-operated Air Chuck and Cam-actuated Facing Attachment for machining the Outer Ring

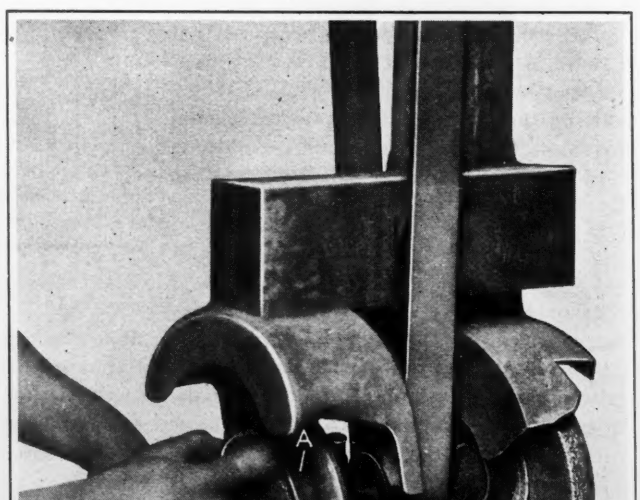


Fig. 5. Grinding Stand and Hand Clamp for holding the Outside Piston-rings while performing a Snagging Operation on the Inside

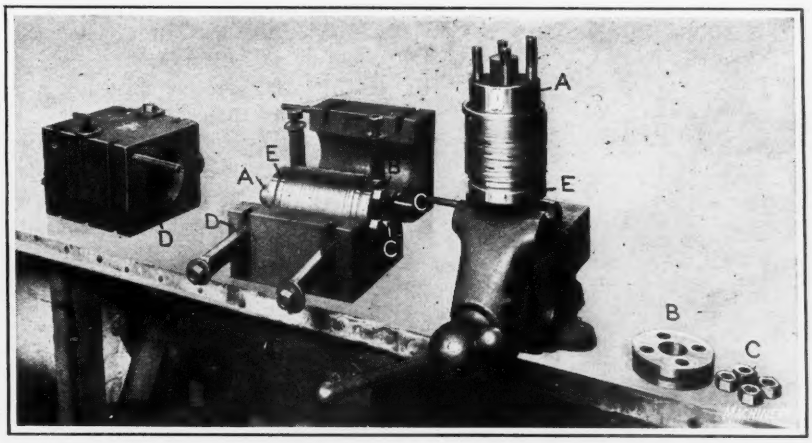


Fig. 6. Special Form of Arbor for holding Outside Rings while finish-turning, and Fixture for centering the Rings on the Arbor

than the outside of the work, and the purpose of this setting fixture is to bring the outside of the piston-rings concentric with the lathe center holes at the ends of the arbor, rather than to have the rings located from their snagged inside diameter, as was the case in performing the rough-turning operation referred to in the preceding.

It will be seen that the setting fixture consists of two blocks which fit together to form a cylindrical opening of the same diameter as the piston-rings that are to be finish-turned. With the clamping collar *B* and the nuts *C* still loose, the work is placed in this fixture as shown at the center of Fig. 6, after which the upper block is swung down and bolted tightly over the work. This brings the work concentric with the lathe center holes in the arbor, because the collars *B* and *E* on the arbor are supported in openings at the ends of the fixture that are concentric with the larger opening that holds the work. This fixture serves the additional purpose of preventing the piston-ring castings from shifting in a sidewise direction while the clamping nuts *C* on the arbor are being tightened.

When the work has been secured firmly in place, a finishing cut is taken over the rings, after which the arbor and its load are removed from the lathe and reset in a fixture of the type shown in Fig. 6. This fixture has a cylindrical opening 0.025 inch in diameter larger than the one used for the first setting. As the split piston-rings were somewhat compressed in placing them in the first fixture, when the clamping nuts *C* and collar *B* of the arbor are released, the work will expand, so that in resetting, the rings are clamped somewhat further open than previously. Held in this way, the arbor is replaced in the lathe for taking a final finishing cut over the outside surface.

Turning the Bevel on the Inner Side of the Rings

After the rings have been finish-turned, it is necessary to bevel their inner sides, and for this purpose Porter-Cable short-bed lathes, furnished with a tool equipment of the type illustrated in Fig. 7, are used. As the rings have been split and are subject to a springing action, it is necessary to provide means for holding them securely in place, and this is done by the use of a special type of male center *A* and a female center *B*, between which the ring *C* is held. The female center is counterbored to such a diameter that the ring can just be slipped into place, and the male center engages the inside of the work so that there is no chance for slippage or distortion. Both of the centers are beveled in such a way that the tools can reach the work to perform the required beveling operation.

At the back of the lathe, there is a formed tool *D* that is first brought into contact with the work to "hog off" the excess metal, after which a single-point tool *E* carried on a compound rest at the front of the lathe cross-slide is fed across the work to take a finishing cut. The roughing tool *D* is carried by an auxiliary tool side to which a rack is secured. This rack meshes with gear *F*, which is turned through the rotation of pinion *G*, the entire mechanism being operated by handle *H*.

Finish-grinding the Inside Diameter

The final operation in manufacturing the outer piston-rings consists of finish-grinding the previously snagged inside diameter. This is done by locating a number of the castings in a pot fixture, so designed that the rings are compressed and slipped into this fixture, when they expand and are held from their finish-turned outside diameter. At the front end of the pot are a collar and clamping bolts, and the pot fixture is loaded with piston-ring castings until the last ring projects slightly beyond the end of the pot. When the clamping bolts are tightened and the collar of the fixture is forced against the end casting of the row, the whole load is secured firmly in place. The pot fixture is mounted on the spindle of a Heald internal grinding machine, and an abrasive wheel is reciprocated inside the piston-ring castings to grind the inside concentric with the outside.

Mention has already been made of the fact that the two outer members of the V-plex piston-rings are machined from

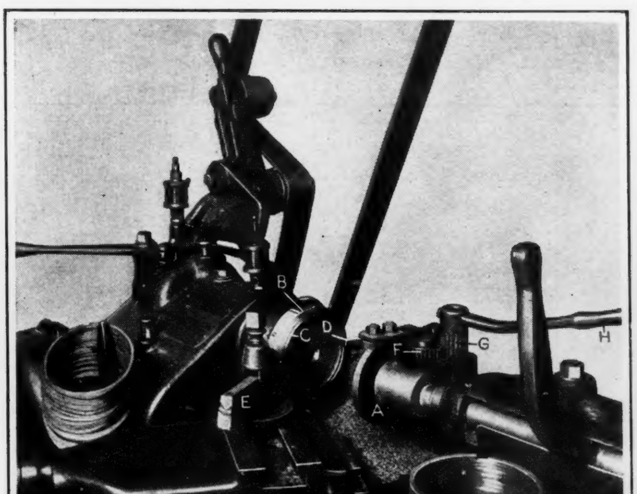


Fig. 7. Short-bed Lathe equipped with Special Centers and Facing Attachment for turning Beveled Surface on Outside Piston-rings

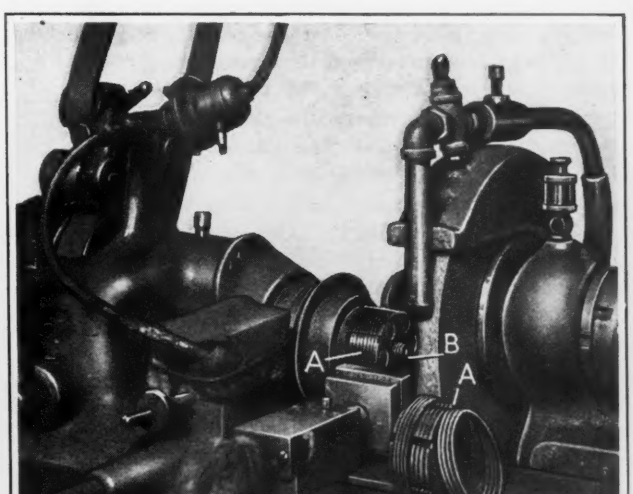


Fig. 8. Special Magnetic Chuck Adapter used for holding the Inner Piston-rings while grinding the Outside Diameter

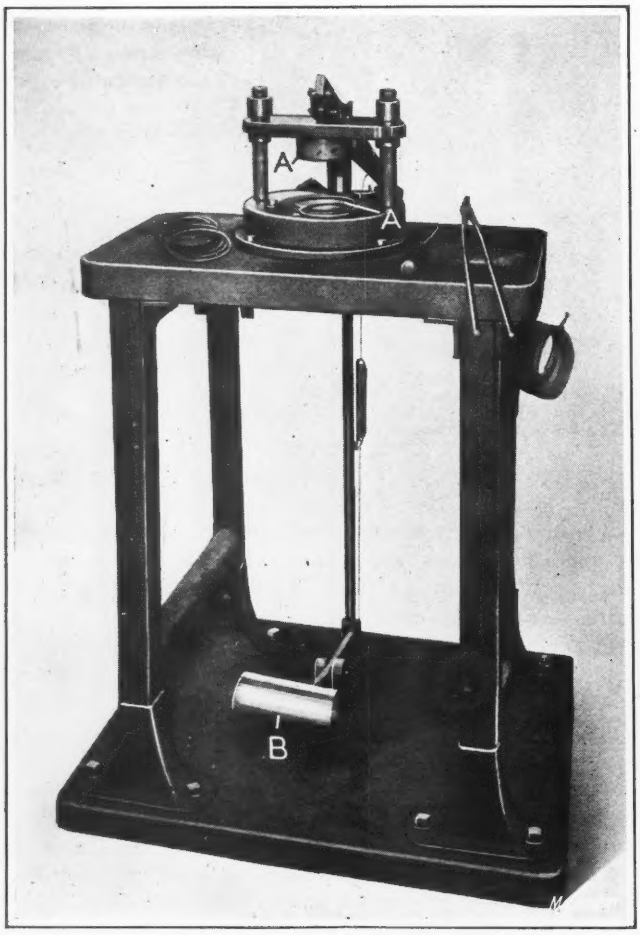


Fig. 9. Combination Straightening and Tempering Die used in making the Inner Rings

individual gray iron castings. For making the central member of this three-part ring, a special steel is used. The rings are formed to a V-shape, and after they have been machined to the proper form, they are sent to the heat-treating department, where the temperature of the steel is raised to between 1400 and 1500 degrees F. in a special gas furnace. Upon removal from this furnace, the rings are dropped successively into a die shown at *A*, Fig. 9, which is operated by a foot-treadle *B*. This operation serves the double purpose of bringing the rings into a truly round form and of giving them a spring temper, as the closing of the die not only sets the ring in the required shape, but it also withdraws the heat rapidly enough to give the steel the required physical properties.

Grinding the Outside Diameter of the Inner Rings

For grinding the outside diameter of the inner rings, which is the only surface on these parts that is machined, use is made of adapters of the type shown at *A*, Fig. 8, which are slotted in such a way that eight of the rings can be ground at a time. This adapter fits on a special magnetic chuck, which has a pilot *B* that passes through the opening in the adapter, and there are electromagnetic windings that pull the adapter back against the face of the chuck, where it is held firmly in place. Aside from the method of holding the work, this is an ordinary cylindrical grinding operation.

Gaging the Finished Rings

V-plex piston-rings are required to have the beveled face concentric and of a uniform angularity. They are tested for this condition by means of special gages *A* shown in Fig. 10, which are furnished with dial test indicators. The piston-ring is dropped into place on this gage, the beveled surface being held under the needle of the indicator. Then the ring is rotated, and in order to pass inspection the concentricity or angularity of the beveled surface must not vary enough to deflect the needle more than 0.001 inch.

Next, the rings are tested for freedom from flaws by forcing them over a plug gage *B*, which is 1/32 inch larger in diameter than the piston on which the rings are to be assembled. The importance of this test will be readily appreciated when it is borne in mind that the two outer rings of each set are made of cast iron, and if there were any serious flaw in a ring, it would be likely to result in breakage when the ring was spread to put it in place on the piston.

For testing whether or not the sets of inner and outer rings can be assembled together with satisfactory results, use is made of special plug and ring gages *C*, which correspond in size to a piston and to the cylinder in which such a piston would operate. The plug gage is grooved so that the set of piston-rings can be assembled in place, and after it is filled, the plug gage is pushed into the ring gage. In this way, the action of the three assembled rings may be inspected under conditions that duplicate those of actual service in an automobile engine. Finally, the "spring," or the amount of resistance to compression offered by the cast-iron outer piston-rings, is tested by means of a simple fixture consisting of a platform scale *D* on which the ring is supported, and a lever *E* carrying a yoke that engages the top of the ring. This lever is pushed down until the slot in the ring has been closed, and the inspector then reads on the scale the direct measure of the resistance that the ring offers to compression.

* * *

INCREASED EFFICIENCY IN PRODUCTION

We must get our minds away from the notion that pre-war standards of living and volume of business would be normal now. "Normalcy" is a vastly higher and more comfortable standard than that of 1913. We must not judge the state of business activity by pre-war figures, but by a hugely increased base. We must not be frightened when our output of steel or textiles or automobiles, lumber, corn, or hogs, or our car loadings amount to figures far in excess of those implied in a normal growth of population.

There has been in the last decade an unparalleled growth of our industrial and commercial efficiency and our consequent ability to consume. We are producing a larger amount of commodities per capita than ever before in our history. Precise comparisons are difficult to adduce, but exhaustive study from many angles of production over average periods ten years apart, before and since the war, would indicate that while our productivity should have increased about 15 per cent, due to the increase in population, the actual increase has been from 25 to 30 per cent, indicating an increase in efficiency of somewhere from 10 to 15 per cent.—*Herbert Hoover*

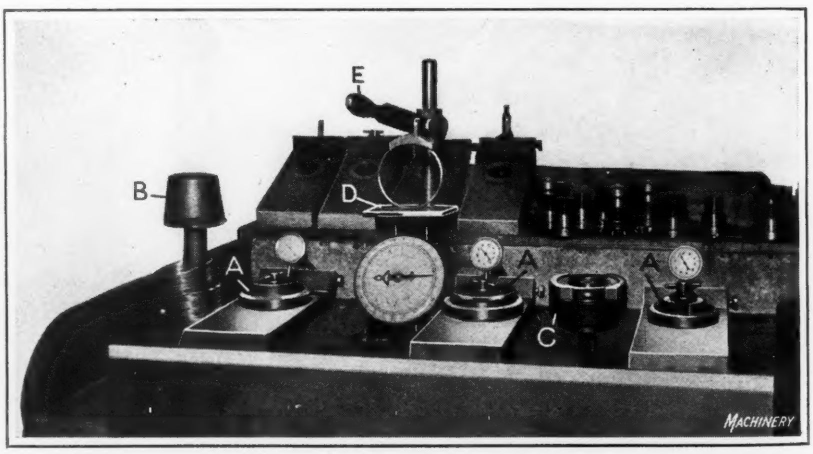
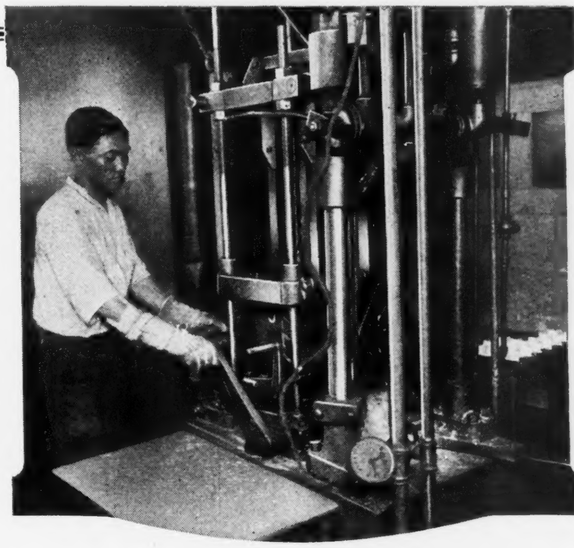


Fig. 10. Gages and Testing Devices used for inspecting the Finished Rings

Die-castings Requiring Two Operations

By CHARLES PACK, Vice-president and Chief Metallurgist, Doehler Die-Casting Co., Brooklyn, N. Y.



WHILE, in a sense, all die-castings have special features, there are certain designs of castings that tax the ingenuity of the die designer to find a method for their commercial production. The production of die-castings which at first glance would seem impossible of accomplishment, is often made possible by employing two operations. The casting produced by the first operation in reality becomes an insert in the second casting, but being of the same metal, it is fused with the second casting, the two thus becoming one solid piece. Examples of work of this kind include tubular shapes having a projection or other irregularity that prevents the ready removal of the central core. In this article, three such castings are to be considered. They are the syrup dispenser top shown in Fig. 1 and two graphophone tone-arms, both of which are used on well-known phonographs.

The syrup dispenser top is a tin-base casting, and the difficulty encountered in producing it was due to the spout being at an angle with the remainder of the cored section. This casting was made in the following manner: A straight copper tube *A* was cast into the first operation casting *B*, to form the spout. This casting was then bent to the proper angle, inserted in the die, and the remainder of the part cast around it. This is a very simple procedure after the method has once been evolved, but the solution of the problem at first glance appears much more difficult.

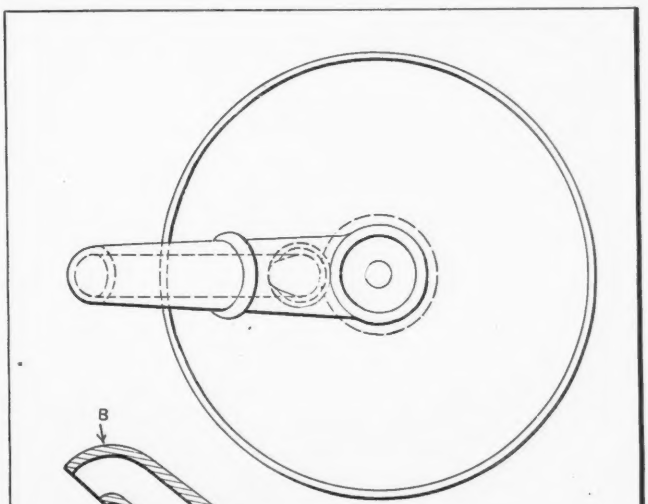


Fig. 1. An Example of a Two-operation Die-casting

Casting a Graphophone Part

The appearance of the first-operation casting for a Columbia graphophone tone-arm is shown at *A*, Fig. 2, while a sectional view of the finished tone-arm is shown at *B*. This tone-arm is a zinc-base casting. The first-operation dies are partially illustrated in Fig. 3. This illustration shows a sectional view of the ejector die in alignment with the cover die, a partial plan view of the ejector die and a sectional view through the ejector die, showing one of the cores. The die contains two impressions, which are symmetrically arranged and fed by one gate *A*. The plan view shows only half the die. The other half is identical in construction with the portion shown in the plan view, but the impression is reversed.

The sectional view through the small elbow core shows the arrangement for withdrawing the two cores that form the elbows. These cores join the long tapered core at a 45-degree angle, and are constructed so that as much of them can be removed at right angles from the tapered portion as is possible. The pinion *B* by which these cores are drawn is shown, as well as the means for locking the cores after they have been advanced to the casting position. The design of these two-impression dies cannot be regarded as out of the ordinary, the point of interest being the unusual method of producing the castings. The two die members are aligned by posts in the regular way, and they fit together with a shoulder and are locked by the locking member *C*, which contains a slot in which a stud on the ejector die becomes wedged. Not only are the dies properly cooled, but a water line is also run through the sprue-cutter *D*.

The long tapered core which is operated by pinion *E* not only produces the tapered hole in the tone-arm, but also forms an opening through the elbow from which it is withdrawn. Referring again to the view *A*, Fig. 2, it will be seen that the edges of the opening are beveled and that the metal at this end of the casting is somewhat thinner than the remaining section; also there are annular beads *D* and *E* cast on the elbow. This casting is used as an insert for producing the finished tone-arm, the method being protected by patents.

Second Operation on Tone-arm

The beads on the first casting are the means for anchoring the newly added metal which is cast on this end of the casting in the second operation. By this means the exterior surface is made uniform around the elbow, and the core opening produced in the first operation is closed.

The die used is also shown in Fig. 2. It is a two-impression die, but only the large end of the first-operation casting is placed in the die for casting on the additional metal. A core fits into the open end, as shown at *G*. This closes the end, and the

core is so shaped that a uniformed curved surface is cast on the interior of the elbow. Special sleeve cores are also fitted into the die to form the shoulder, as indicated at *H*. These sleeves are advanced into the die impressions by two 5/8-inch pinions, and locked by a suitable clamp. The cores *G* which pass through the sleeves are operated by a single pinion.

The metal is admitted through a central gate to both impressions, this gate being shown in the plan view of the cover die. The water lines for cooling both members of the die, are shown in the illustration, as well as the ejector-plate *J* and the rack and pinion arrangement for operating it. This is a case where the ejector-pins must not project into the die impressions so far as to cast a shallow hole in the work, for that would be difficult to obliterate with a file. The plan view of the ejector die shows that two ejector-pins are sufficient for each casting.

Another Example of Two-operation Work

The third example of a two-operation die-casting is the Aeolian tone-arm, which is a tubular part having a compound curve, presenting a unique problem in die-casting. This tone-arm is shown in detail in Fig. 4. The patented scheme employed in casting this piece consists of first making two hollow castings, then fitting them together and casting the metal as in insert work, to complete the tone-arm. The first-operation dies shown illustrate how this is done.

The two special castings used as inserts in the second operation are produced in this two-impression die. One casting is an elbow, produced in the left-hand impression. For this part, two cores are employed, which meet at a 45-degree angle and are drawn at right angles to each other by racks and pinions. The shape of the casting is indicated at *A*. The other casting is produced in the right-hand impression, as indicated at *B*. Castings *A* and *B* fit together, as shown in the plan view of the work in the lower right-hand corner of the illustration, and form a sectional core for all but the large end of the tone-arm, in the second operation.

Casting *B* is made by means of a curved tapered core, which extends beyond the ends of the die impression and is located by two pins *C*. These pins hold the ends of the core tightly in pockets in die-block *E*. This construction stops off

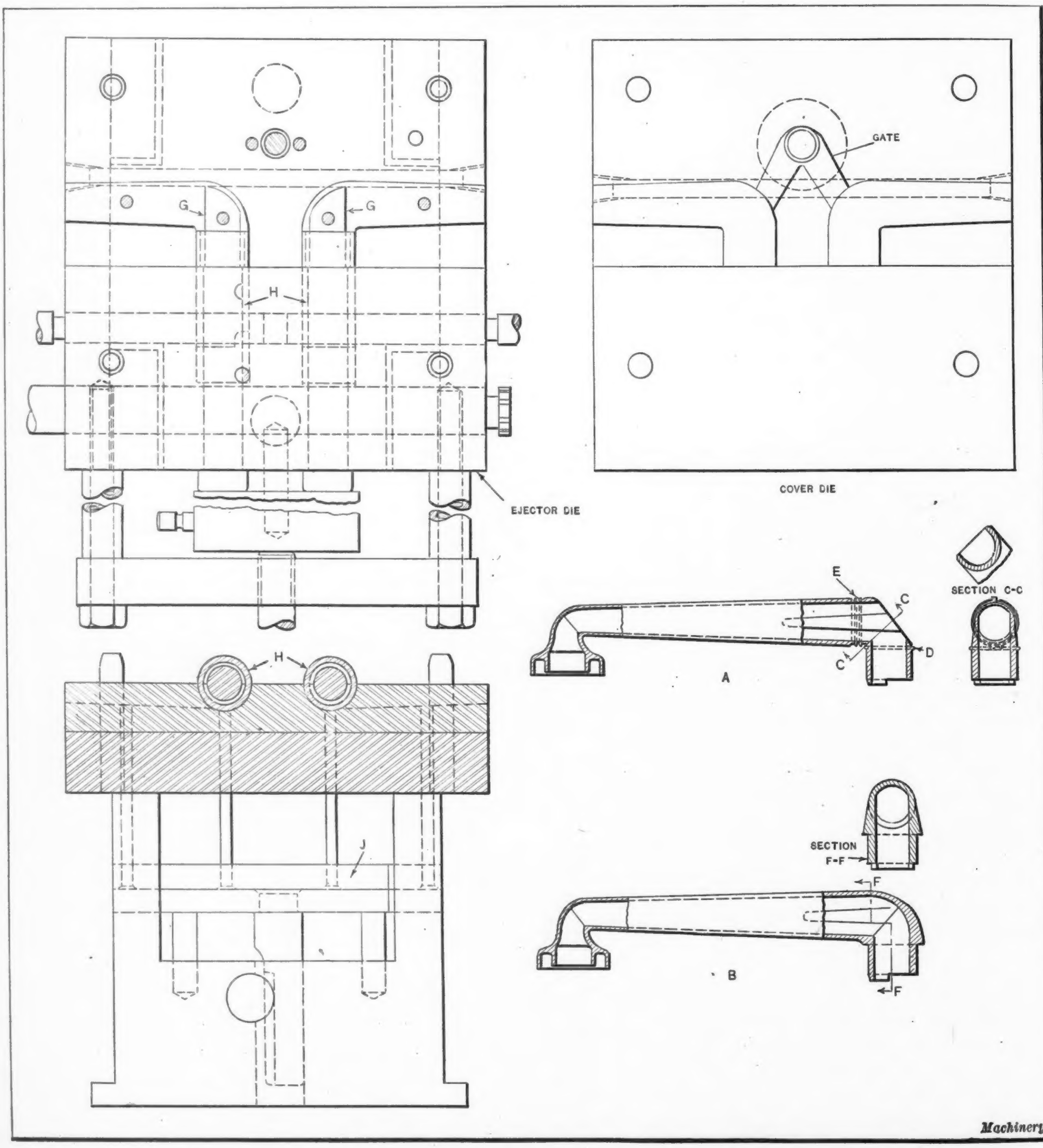


Fig. 2. Second-operation Die used in casting the Graphophone Tone-arm, and Detail Views of the First- and Second-operation Castings

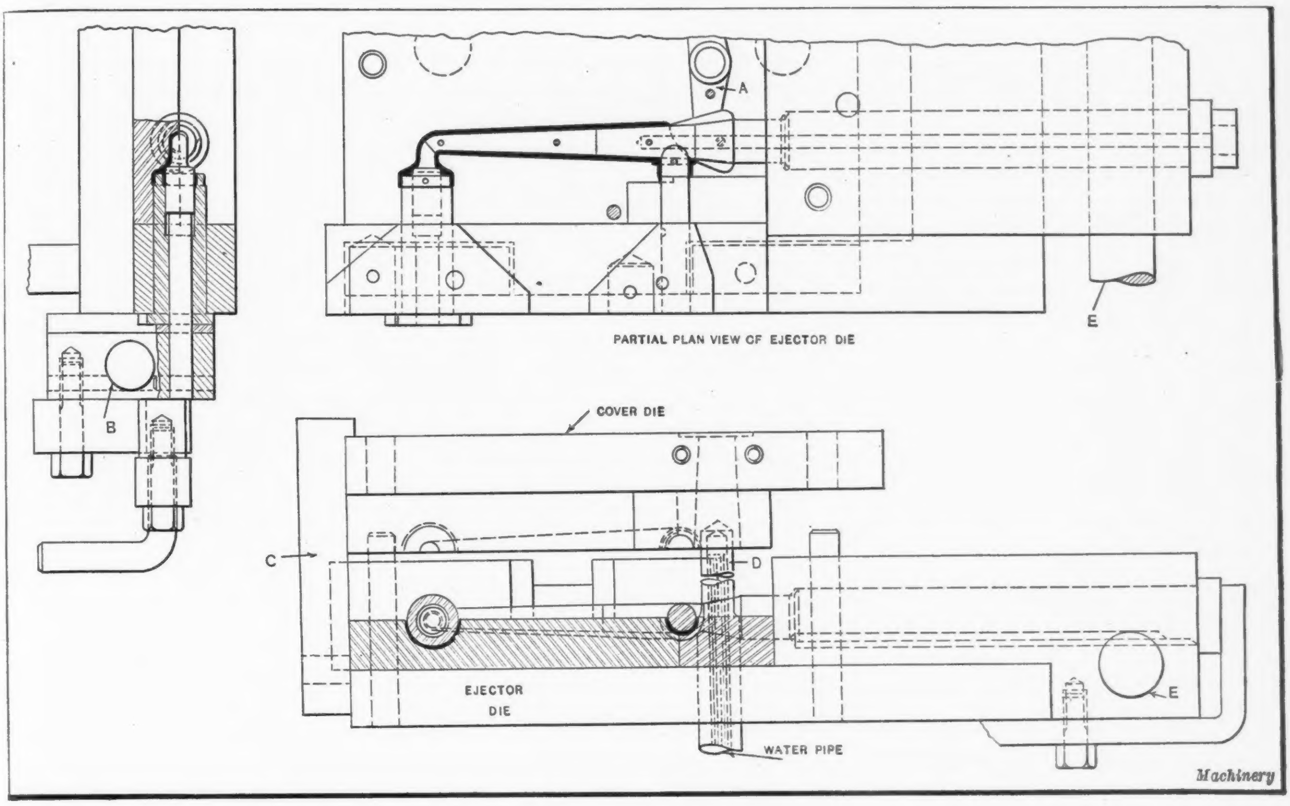


Fig. 3. First-operation Dies employed in casting a Graphophone Tone-arm. Only One of the Two Impressions in the Ejector Die is shown

the metal in the casting on the line where die-block E matches the die-block containing the casting cavity. The core is located by a projection on the small end. After the casting has been made, it is ejected from the die with the core in place. The core is then pushed through the casting and removed.

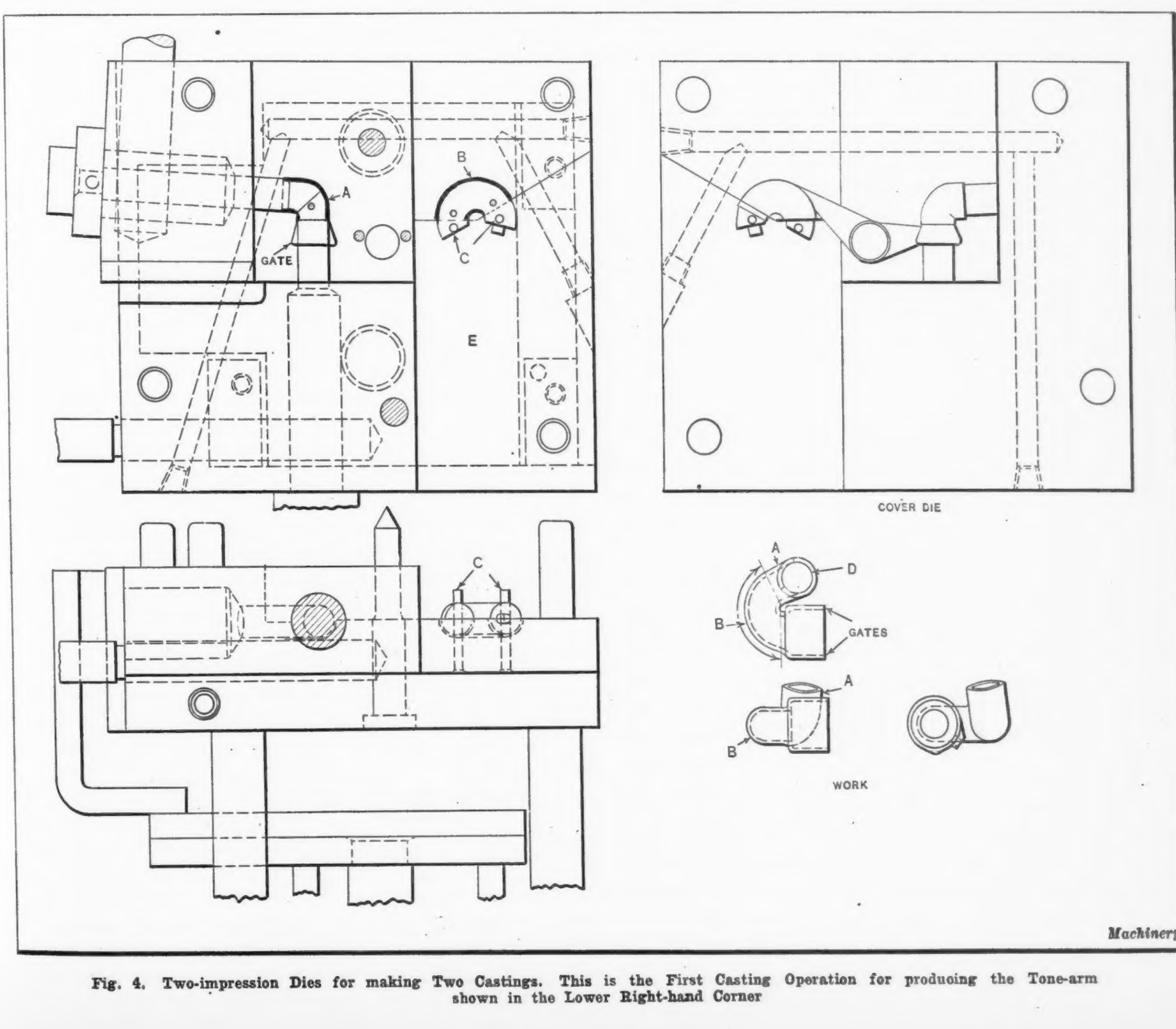


Fig. 4. Two-impression Dies for making Two Castings. This is the First Casting Operation for producing the Tone-arm shown in the Lower Right-hand Corner

The plan view of the cover die shows the method of gating both impressions from the sprue passage. It will be noticed that the gate for the small elbow leads to the end of the casting, whereas that for the other casting leads to the side. This is not objectionable here, because the fin left by the removal of the gate is cast over in the second operation. Dies for the second operation are not shown, but this is accomplished by the use of two plug cores, one to close up the hole *D* and the other to form the interior of the hole at the opposite end. The metal is fed through gates connecting at the large end of the tone-arm, this end being cast complete and metal being added, like a shell, to unite the two separate castings *A* and *B*.

This die is a good illustration of how sectional construction may be adopted to advantage to facilitate machining the die impressions. The ejector die in this case is constructed of separate sections fitted together, each of which offers no particular difficulty in machining. This principle is extensively used in die construction.

* * *

CLOSE RELATION BETWEEN ENGINEERING AND PATTERN DEPARTMENTS

By B. RUPERT HALL
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The connection between the engineering department and the pattern shop of a manufacturing plant is a close one. Both the designing engineer and the patternmaker are confronted with the same general condition, namely, the necessity of creating something from nothing. Every other manufacturing department in a commercial organization has some tangible object to work on. The pattern shop, alone of all the production divisions, shares with the engineering department the responsibility for displaying creative power.

It is for this very reason, perhaps, that most modern pattern shops are not operated more strictly on a production basis. In the average shop, each patternmaker is to a great extent allowed to exercise his own judgment in constructing a pattern. Comparatively little effort is made to supervise processes or to systematize methods. As a result, efficiency has suffered somewhat, although not so much perhaps as would have been the case in some other branch of craftsmanship. The result of this system apparently has been to raise the standard of workmanship of the individual artisan, and as a consequence the system has been fairly satisfactory, although wrong in theory. Nevertheless, there is plenty of room for improvement in the present-day pattern shop. A certain tendency is noted in the direction of constructive change, marked by a constantly increasing effort to separate the work of planning from the manual construction of patterns. Such a change in method will, of course, tend to result in specialization, with a corresponding decrease in all-around proficiency. However, the efficiency of production is sure to be very much increased.

The proper construction of patterns is a matter of vital importance to any manufacturing plant. An error in making a pattern that is to be used in large production will inevitably cause a serious monetary loss. It is fully as serious an error and just as costly to design a part for which the pattern and casting may be easily made, but which is difficult and expensive to machine. In cases of this kind, a few words of criticism from a competent advisor, offered while the design is taking form, would result in alterations that might effect a great saving. These are the conditions under which the engineering department and the pattern shop should establish closer contact. If the cooperation between the engineer and the patternmaker were close enough, most serious errors would be avoided, and a great deal of the trouble at present encountered in the machine shop and on the assembling floor would be eliminated.

How Cooperation can be Effected between the Drafting-room and Pattern Shop

It is evident that the proper place to determine the method of making a pattern is in the engineering drafting-room; in other words, the casting must be so designed as to facilitate molding to the greatest degree. However, the average designer cannot be expected to be a specialist in every branch of production methods, and when it comes to the refined detail of pattern construction, a specialist is needed. The logical way to take care of this requirement is to obtain a man, well informed as regards both pattern shop and foundry practice, and to place him in the drafting-room and have him check all pattern drawings before they are issued to the shop. He is thus in a position to change any expensive features in the original design of the casting. At the same time, he can plan the method of constructing the pattern and core-boxes, if any are required, so that this does not need to be done in the pattern shop later on. The real thinking required in the manufacture of the casting from the original blueprint is done in designing and making the pattern. Consequently, it is obvious that a capable, trained man from the pattern department should make the best man for the purpose outlined.

There can be little doubt that a definite method of cooperation between the engineering department and the pattern shop, as outlined in the foregoing, would vastly improve the results obtained at present. This can be effected by more systematic methods and by organizing the two departments so as to function as one in the matter of planning for the production of castings.

* * *

PROPOSED STANDARDIZATION WORK

The American Engineering Standards Committee has prepared a list of more than 1000 items in connection with which standardization work or simplification of practice could be undertaken. This list has been prepared at the request of Secretary Hoover, and is in the form of a summary of answers to a questionnaire sent out by the American Society of Mechanical Engineers. The suggestions for standardization work relate to the automotive industry, the building industry, the electrical industry, the machine shop equipment field, the power plant field, the railroads, paper and printing, and miscellaneous subjects.

In the machine shop field, some of the standardization subjects are as follows: Ball bearings; bronze bushings; driving chain; conveyor chain and sprockets; chucks; cotter-pins; flexible couplings; rigid couplings; direct-connected machinery; die notches and die tongues; flat taper files; file handles; gears and gear reductions; gear tooth forms; hammers; hangers; lathe centers; lathe and drill press spindle tapers; grinding wheels; micrometers; lubricating oils; cutting compounds; core oils; rivets; screws; screw threads (pipe and bolt); heads on bolts and screws; nuts (hot punched and cold punched); spindle noses; tapers; taper pins; universal joints; acetylene welding and cutting blow-pipe; wrenches; and wire and sheet-metal gages.

* * *

STEEL USED FOR GAGES

A very satisfactory steel to use for gages for interchangeable manufacturing work—both working and inspection gages—contains from 0.15 to 0.25 per cent of carbon, from 0.90 to 1.20 per cent of manganese and from 0.04 to 0.06 per cent of phosphorus and sulphur. It should contain no silicon, as silicon causes warping in hardening and hence is undesirable in a gage steel. Gage steels with compositions as follows, however, may be accepted as satisfactory: Carbon, from 0.10 to 0.35 per cent; manganese, from 0.50 to 1.20 per cent; phosphorus and sulphur, not more than 0.12 per cent; and no silicon. It is generally believed that it is best to have the carbon at a low limit of about 0.15 per cent.

Replacing Castings with Stampings

Fig. 1. Humidifier Castings and Pressed-steel Parts used to replace them

Fig. 2. Blanks, Shells and Piercing Die used in making Drip Bowls for Humidifiers

PRESSED metal is beginning to be used to a considerable extent to replace thin cast shells. Several interesting substitutions of this kind have been made by the Worcester Pressed Steel Co., Worcester, Mass., and the examples here presented may suggest similar uses of pressed metal to others. If this substitution can be successfully made, there are obvious advantages to be gained, not the least of which is increase in strength with reduction in weight. If it can be shown that greater productive costs are not entailed, a more general use of pressed steel will result.

Changes in Design Often Necessary

There are certain things, however, to which attention should be called before specific cases are cited. These may have a bearing on the ultimate decision regarding the use of pressed steel where cast metals were formerly employed. When pressed metal is used, it is often necessary to redesign the piece that has previously been cast, eliminating reinforcement ribs, cast-on bosses, etc., and to devise other constructional details in their place. When the work is cast, lugs and other irregular projections can be cast on, but in pressed-steel work, it is usually preferable, and often necessary, to attach such portions of the part either by welding or riveting. Invariably the thickness of stock used for pressed-steel work is much less than the sectional thickness of castings.

The best results can frequently be obtained by spot-welding two or more thicknesses of metal together, as was done in the manufacture of the parts shown in Fig. 1. By this means the cost of manufacture can often be greatly reduced. Some manufacturers, however, feel a certain amount of apprehension regarding the dependability of a welded joint; but if the welds are made in the correct way, results will be obtained which are comparable, at least, to a riveted joint. In fact, tests have been made in which two thicknesses of pressed steel that had been spot-welded were pried open with a cold chisel and sledge hammer, and it was found that the original metal had failed —not the welded spot. It tore away around the weld, leaving a homogeneous solid thickness of metal, like a circular boss.

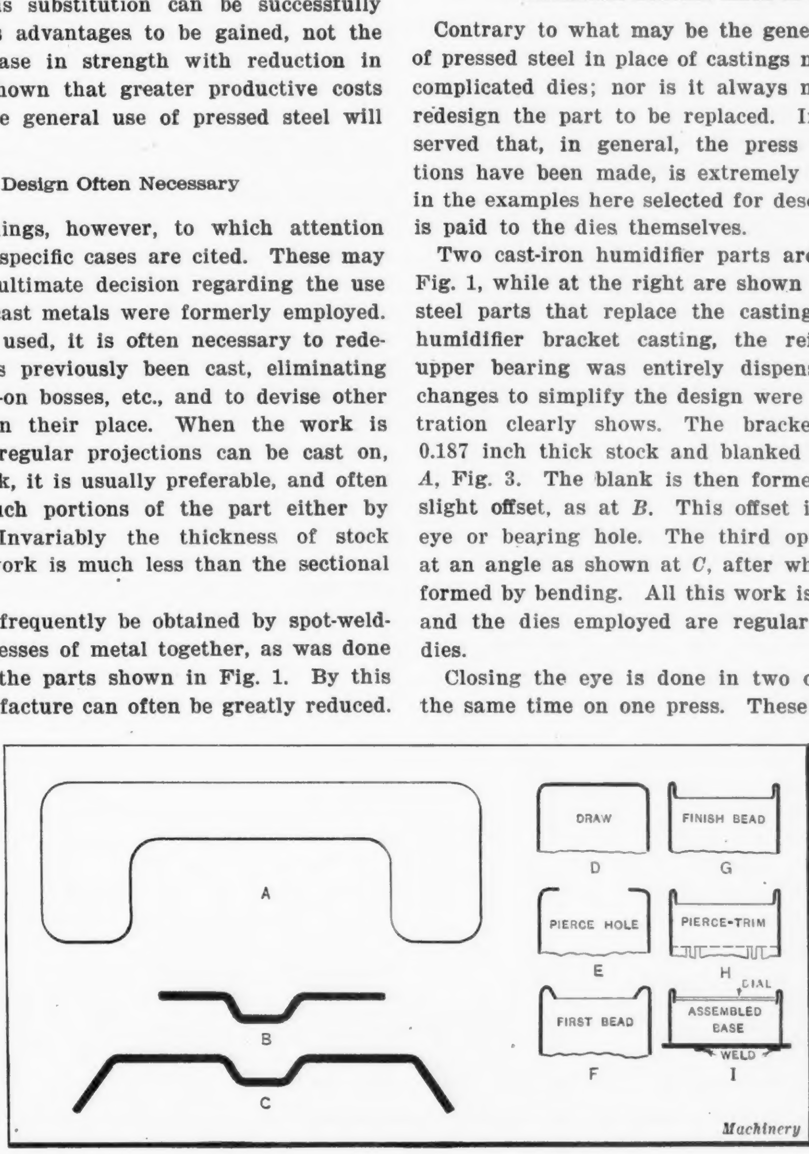


Fig. 3. Diagrammatic Views showing Operations in making Pressed-steel Bracket for Humidifier, and Movement Case for Fire-alarm Box

Humidifier Bracket Made of Pressed Steel

Contrary to what may be the general conception, the use of pressed steel in place of castings need not always involve complicated dies; nor is it always necessary to completely redesign the part to be replaced. In fact, it has been observed that, in general, the press work, where substitutions have been made, is extremely simple—so simple that in the examples here selected for description, little attention is paid to the dies themselves.

Two cast-iron humidifier parts are shown at the left in Fig. 1, while at the right are shown the redesigned pressed-steel parts that replace the castings. In redesigning the humidifier bracket casting, the reinforcing web for the upper bearing was entirely dispensed with. Some other changes to simplify the design were also made, as the illustration clearly shows. The bracket is now made from 0.187 inch thick stock and blanked to the shape shown at *A*, Fig. 3. The blank is then formed at the center with a slight offset, as at *B*. This offset is the beginning of the eye or bearing hole. The third operation bends the ends at an angle as shown at *C*, after which the eye is partially formed by bending. All this work is of the simplest nature, and the dies employed are regular blanking and bending dies.

Closing the eye is done in two operations performed at the same time on one press. These are illustrated in Figs. 4 and 5. A ¾-inch arbor is driven into the partly closed eye, and the bracket held in a vertical position on edge at the front of the die, the slide of the press being used to partially bend the two ends together. The operator next changes the work, which then appears as shown on the bed of the press, Fig. 5, to a horizontal

position, laying it in the die as shown in the illustration. This closes the sides of the bracket together, after which they are spot-welded.

Four welds are made along the lower part of the bracket and three adjacent to the eye. The bolt-holes are pierced after the welding has been completed. The original casting weighed 10 pounds 9 ounces, and the stamping 4 pounds 10 ounces. Thus a gain of approximately 6 pounds in weight has been made, and this has been done without weakening the bracket in any way.

Making Another Pressed-steel Humidifier Part

The drip-bowl casting for a humidifier is shown in the lower left-hand corner of Fig. 1, and its appearance when replaced by pressed steel in the lower right-hand corner. In redesigning this casting, it was found more practicable to make it in two pieces—a bowl and a socket—and to weld these together. The bowl is drawn up from a blank 9⅝ inches in diameter of 0.063-inch stock. Seven operations are employed as follows: (1) Blank; (2) draw in a double-action press; (3) form neck; (4) pierce hole in neck; (5) restrike hole to form shoulder on neck; (6) trim edges; and (7) pierce several small holes. The blank, and the shells after forming the neck and trimming, are shown in the upper part of Fig. 2. As in the case of the bracket, no unusual equipment is required for making the bowl in this way.

The socket member is made from a blank 5 5/16 inches in diameter, of 0.187-inch stock. After blanking, five drawing operations are required to produce the plain cylindrical shell shown in Fig. 2. The first of these operations is performed in a double-action press, and the remainder in single-action presses. This shell is 1 9/16 inches outside diameter and 5⅛ inches long. In the course of drawing the shell, two annealing operations are necessary. The seventh operation consists of necking, and this is followed by piercing two rectangular holes in the sides.

The shell and the punch and die used in piercing the holes are also shown in Fig. 2. The die carries an arbor over which the shell is passed, and there is a loose piece under the outer end of the arbor to support the shell during the piercing operation. The rectangular punch is shown at the left of the die, from which it will be seen that it is V-shaped at the end to furnish the proper shear along the sides of the hole and to give the least cutting resistance. After a hole has been produced in one side of the shell, the work is located 180 degrees from the first position by a latch-block *A* which enters the previously punched hole, the latch-block being raised from beneath by the small lever shown on the die. The casting weighs 4 pounds 10 ounces, and the pressed-steel drip bowl 1 pound 14 ounces.

Fig. 4. First Step in closing the Eye of the Humidifier Bracket

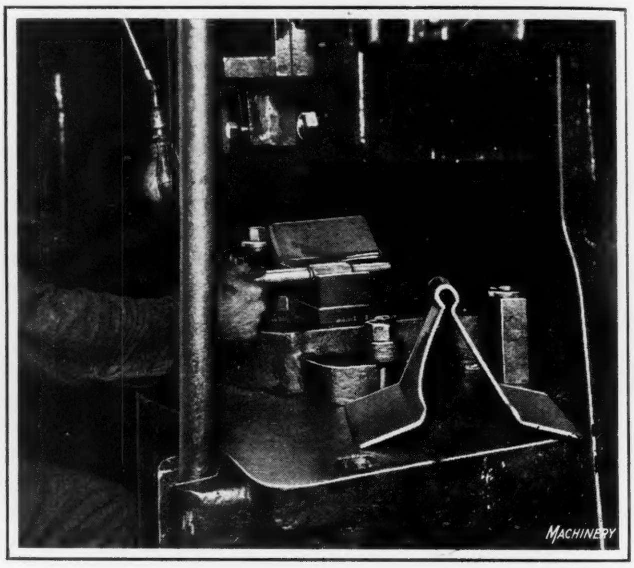


Fig. 5. Closing the Eye, using the Same Set-up as shown in Fig. 4

Pressed-steel Fire-alarm Box

The inside case for the Gamewell fire-alarm box and the movement case confined in it, are shown at the right in Fig. 6. This is the pressed-steel substitute for the cast-iron unit which has been used heretofore. The case or box is drawn up from a blank (shown at the left) the shape and size of which were determined empirically. The rough dimensions of this blank are 16 by 18½ inches, and steel 0.057 inch thick is used. After being blanked, the work is drawn in a double-action press, the shell produced being shown on the blank. This shell is roughly 10¼ inches wide, 12½ inches long, and 3 inches deep, inside dimensions.

The box is then redrawn and annealed, after which it is restruck or sized to form the square corners and several slightly raised bosses. The next operations are trimming the edge and curling, which completes the manufacture with the exception of the minor operations of piercing holes, welding on the door jamb, and assembling steel inserts in the pierced holes for attaching the movement case, etc. It might be mentioned that these holes are slabbed on one side to accommodate the slabbed inserts and prevent them from turning. These inserts are threaded bushings, and are assembled by spinning from the outside of the box.

The movement case is cylindrical, and is made from a drawn shell with a base of thicker stock welded on. The blank for the case is 11⅝ inches in diameter, and the stock is 0.035 inch thick. The blank is first drawn in a double-action press to a shell 7 3/16 inches in diameter and 3 5/16 inches deep. This shell is shown diagrammatically at *D*, Fig. 3. It will be seen from Fig. 6 that a boss is formed on the outside of the shell by flattening the sides, and this operation is next in sequence. The bottom of the shell is then pierced out to form the rim, as shown at *E*, Fig. 3, after which the metal surrounding the hole is formed into a bead, as shown at *F* and *G*. This bead receives the retaining spring for the glass dial on the movement case.

The shell is then held horizontally in the press while three sets of notches, equally spaced, are pierced at the edge, as illustrated at *H*. In the following operation, the shell is trimmed along the dotted line, producing three lugs which, when bent in at right angles, are used to weld through, in assembling the base. The numerous holes are next pierced, and then the base, which is a flat blank with projecting ears for attaching it to the inside of the box, is assembled. This

base is 6¾ inches in diameter and 0.125 inch thick. It is, of course, properly shaped to fit the flattened sides of the case, and in this way serves also to locate the lugs so that the pierced holes will come in the right position when the movement case is fastened in the box.

The cast-iron fire-alarm box weighed 15 pounds 6 ounces, but when replaced with pressed steel as described, there was

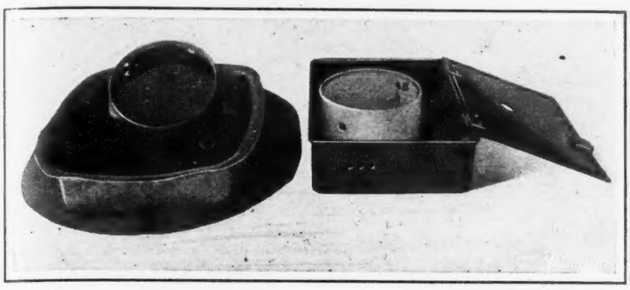


Fig. 6. Pressed-steel Fire-alarm Box with Blank and Shells in Different Stages of Completion

a gain of nearly 6 pounds in weight, the pressed-steel box and case weighing 9 pounds 9 ounces. These examples are typical, and illustrate common methods of replacing castings not involving prohibitive die cost.

* * *

BREAKDOWN TESTS FOR TOOL STEELS

An important method of comparing tool steels is known as the lathe breakdown test. In this test the tool is used for cutting into a steel of definite composition, and works at a known speed and rate of cutting until it is worn out. A report on such tests has been issued by the Bureau of Standards. Important conclusions drawn may be summarized as follows:

1. Breakdown tests are not satisfactory as a basis for the purchase of high-speed tool steels.
2. Competitive comparisons of brands having nearly similar performance is not justified, owing to the qualitative nature of this type of test; but relatively large differences may be determined with certainty, provided sufficient tools are tested and averages of at least two grinds are used in interpreting the results.
3. Certain severe breakdown tests were made with roughing tools on 3 per cent nickel steel forgings, and high frictional temperatures were produced. It was found that the performance of commercial low-tungsten high-vanadium and cobalt steels was superior to that of the high-tungsten low-vanadium type of special steels containing about ¼ per cent uranium and ¾ per cent of molybdenum. The average power consumption in these tests was practically the same, so this factor need not be introduced in comparisons which may be made on the basis of endurance of the tools.
4. Modification of the test conditions, including small changes in tool angles but principally changes in cutting speed, had a more marked effect on the performance of steels containing cobalt or special elements such as uranium or molybdenum than it did on that of the basic types such as plain chromium, tungsten, and vanadium steels.
5. The high-tungsten steels showed relatively poor endurance under severe working conditions, but did much better in more moderate tests. The latter were made on the same test log and with equal cutting speed and depth of cut, but with reduced feed. The frictional temperatures were not so high. Also, in these latter tests the performance of the cobalt steels was better than that of either low- or high-tungsten steels.
6. Hardness determinations and examinations of fractures indicate that the various types of commercial high-speed steel show differences in behavior under heat-treatment and in physical properties which are of importance under moderate working conditions and might counterbalance slight advantages in performance.

STOCK-CLAMPING ARRANGEMENT FOR PUNCHING DIE

By R. H. KASPER

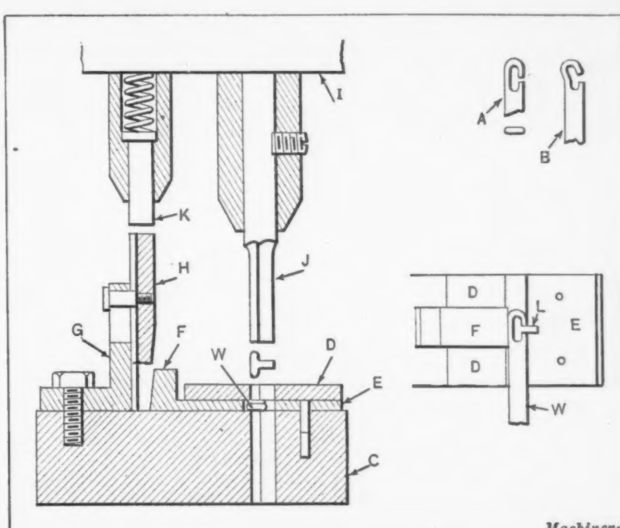
The work shown at *A* in the accompanying illustration was bent or deformed, as shown at *B* when the slot was punched. As this was objectionable, it was decided to provide means for clamping the work on the sides as the punch passed through. This necessitated an arrangement that would hold the work securely and still release it automatically to permit its removal.

The illustration shows a sectional view of the die which was designed for the work and which proved satisfactory. The die member *C* is constructed in the conventional manner. The stripper plate *D* is provided with guide plates *E* and *F*. Plate *E* is held stationary by a pin which enters the die. This plate is grooved, as shown at *L* to permit the tongue of the punch to pass through. The groove is made to correspond accurately with the outline of the die, so as to form practically a continuation of the die, although it does no cutting.

Plate *F* slides in a groove in stripper plate *D*, and is provided with a heel at its back end. The back face of this heel is ground to an angle of 5 degrees with its base. In back of plate *F* is screwed an angle-piece *G*, which carries a sliding plate *H*. Plate *H* is ground at its lower end to an angle of 5 degrees, so as to coincide with the heel of plate *F*. The punch-holder *I* carries the punch *J* and the plunger *K*, which is free to slide in its shank and is backed up by a spring. The work *W* is shown in position between the guide plates.

Operation of Clamping Arrangement

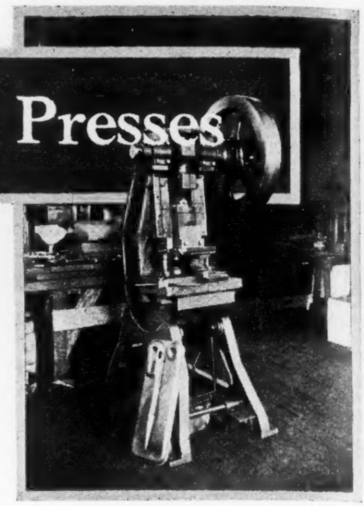
In operation, as the ram of the press descends, plunger *K* comes in contact with sliding plate *H*, and forces it downward. Plate *H* comes in contact with the heel of plate *F*, and, owing to the angularity of the two surfaces in contact, plate *F* is moved to the right, pressing the work against plate *E*. At this point punch *J* has not yet entered the stock. When the punch enters the work, the stock is prevented from being distorted by plate *F*, which is wedged against the work by plate *H*. The angular faces on plates *F* and *H* per-



Punching Die provided with Clamping Arrangement designed to prevent Work from being deformed

mit the latter plate to serve as a wedge in back of plate *F*, so that motion cannot be imparted by plate *F* to plate *H*. The result is that plate *F* becomes immovable when it touches the stock, holding it so securely that it will not be bent. As the ram ascends, plates *F* and *H* are returned automatically to their original positions by springs (not shown in the illustration).

Design of Inclinable Power Presses



Proportioning the Frame, Fly-wheel, and Other Parts—Second of a Series of Articles

By P. A. FRIEDELL

In designing any type of machine, there is always a proper place at which to start. In the case of a power press, this place is the crankshaft; then follow the reciprocating parts, the frame, and the driving mechanism. The crankshaft may be considered as the foundation on which the press is built, and a press, uniform in strength and pleasing in outline, can only be produced by this method. Many errors in the design of presses can be attributed to the fact that the frame is designed first, and the other parts, including the crankshaft, are made to suit the frame; this results in a machine with weak points and unsatisfactory lines.

Calculations covering the crankshaft, main bearing and connection caps, connection, connection screw, ball cap, and slide for an inclinable press of specified capacity were presented in the first article of this series which appeared in January MACHINERY. The present article covers the design of other important members of the same press. Some of the dimensions calculated in the first article will be used in this article; these values are given in the following, together with the figure numbers of the first article in which they were shown:

D, Fig. 1 (crankpin diameter) = 5 9/16 inches;
d, Fig. 1 (crankshaft diameter) = 4⅜ inches;
t, Fig. 1 (throw of crank) = 1 inch;
J, Fig. 5 (length of gibway on slide) = 23⅛ inches;
R, Fig. 5 (width of gibway on slide) = 1⅞ inches;
G, Fig. 2 (length of main bearings) = 7 11/16 inches;
L, Fig. 5 (length from end of thread to center of ball on connection screw) = 6¼ inches;
K, Fig. 5 (distance from center of connection ball to bottom face of slide) = 11 9/16 inches;
G, Fig. 3 (length of connection) = 13 3/16 inches minimum;
F, Fig. 2 (height of boss on main bearing) = 9/16 inch;
W, Fig. 5 (width of slide) = 12 inches;
G, Fig. 5 (dimension on slide) = ¼ inch;
S, Fig. 2 (diameter of main bearing cap studs) = ⅞ inch;
M, Fig. 5 (dimension on slide) = 1⅝ inches.

Designing the Gibs

Gibs for an inclinable power press should preferably be made of the straight pattern shown in Fig. 6. Several other good designs are shown in MACHINERY'S ENCYCLOPEDIA, Volume III, pages 413 to 418, inclusive. However, the design illustrated in Fig. 6 has been almost universally adopted for the inclinable press. Referring to this illustration,

$$L_1 = 2D + 1.5t + 10 = (2 \times 5.56) + (1.5 \times 1) + 10 = 22.62 \text{ or } 22\tfrac{5}{8} \text{ inches}$$

$$S_1 = 0.15d + 0.25 = (0.15 \times 4.375) + 0.25 = 0.91 \text{ say } \tfrac{7}{8} \text{ in.}$$

$$T_1 = R + 0.125 = 1.875 + 0.125 = 2 \text{ inches}$$

$$C_1 = T_1 + 0.5S_1 = 2 + (0.5 \times 0.875) = 2\ 7/16 \text{ inches}$$

$$W_1 = C_1 + S_1 + 0.125 = 2.437 + 0.875 + 0.125 = 3\ 7/16 \text{ inches}$$

$$E_1 = 1.5 \text{ to } 2S_1$$

$$P_1 = 7 \text{ to } 9S_1, \text{ about } 8S_1 \text{ desirable.}$$

As $8S_1 = 8 \times \frac{7}{8} = 7$ inches, it will be necessary to take a slightly lower value, say 6½ inches for P_1. For three spaces this will total 19½ inches and leave 3⅛ inches for the two ends, making $E_1 = 1\ 9/16$ inches. This value falls between the limits of 1.5 to $2S_1$, and is therefore satisfactory. The holes S_1 in the left-hand gib should be made ⅛ inch oblong sideways to enable side play of the slide or ram to be eliminated by adjustment.

Determining the Frame or Housing Dimensions

The frame will next be considered, first laying out the parts of which the proportions are known, and then building the gib and main-bearing section of the frame around these parts. The faces of the main bearings should be made to suit the main bearing caps dealt with in the first article, and the slide section shown in Fig. 7 should be made to suit the slide and gib. It is customary, in the case of inclinable presses, not to allow the bottom face of the slide to enter the gibs at the top of the stroke. This permits the use of dies and punches that are larger than the bottom face. Under such circumstances the slide face may come within ⅛ or ¼ inch of the gibs. This practice, of course, is not to be recommended, especially in blanking or similar work where it can be avoided; the more thoroughly the slide is supported at the point of maximum load, the less chance there is of shearing the dies or producing ragged edges on the blank.

After laying in the main bearings, the distance H_1, Fig. 8, from the horizontal center line of the crankshaft to the bottom of the gibways may be calculated. It is necessary to find the minimum distance from the center of the connection bearing calculated in the first article to the bottom of the slide. This equals $G + L + K$ (in which G is the dimension given in Fig. 3 of the first article and L and K are given in Fig. 5) = 13 3/16 + 6¼ + 11 9/16 = 31 inches. Adding the throw of the crank (1 inch) gives 32 inches for length H_1, Fig. 8. Therefore

$$G_1 = H_1 - L_1 = 32 - 22\tfrac{5}{8} = 9\tfrac{3}{8} \text{ inches}$$

If the press is designed so that it will take dies wider than the slide face, dimension H_1 should be less than the value given, an amount equal to the throw of the crankshaft plus ⅛ inch. Then,

$$H_1 = 13\ 3/16 + 6\tfrac{1}{4} + 11\ 9/16 - (1 + \tfrac{1}{8}) = 29\tfrac{7}{8} \text{ inches}$$

and

$$G_1 = 29\tfrac{7}{8} - 22\tfrac{5}{8} = 7\tfrac{1}{4} \text{ inches}$$

Dimension G_1 should never be less than $1.2d + 1$ when the bottom slide face is to enter the gibs; in the present case this equals $(1.2 \times 4.375) + 1$ or 6¼ inches. When the slide face

may enter the gibs, G_1 should not be less than $1.2d + 2t = (1.2 \times 4.375) + (2 \times 1)$ or $7\frac{1}{4}$ inches.

Designing Various Frame Sections

Referring to the cross-section of the gibways shown in Fig. 7, which is taken along line X–X, Fig. 8, U_1 should be made equal to T_1, Fig. 6, or 2 inches, and, of course, S_1 is the same as in Fig. 6, or $\frac{7}{8}$ inch. $S_2 = S_1 - \frac{1}{8} = \frac{7}{8} - \frac{1}{8} = \frac{3}{4}$ inch. The set-screws should be placed midway between the gib studs, as shown in Fig. 8, and are used for adjusting the gibs so as to obtain proper alignment of the slide, a matter which is very important for efficient operation of the dies.

$$B_1 = 0.5\ T_1 + 0.25 = (0.5 \times 2) + 0.25 = 1\tfrac{1}{4} \text{ inches}$$

Dimension A_1 must equal one-half the distance across the slide and gibs $= \dfrac{W + 2G + 2W_1}{2}$ in which G is the dimension given in Fig. 5 of the first article. Therefore,

$$A_1 = \frac{12 + (2 \times 0.25) + (2 \times 3.4375)}{2} = 9\ 11/16 \text{ inches}$$

and

$$C_1 = A_1 + 1/16 = 9\ 11/16 + 1/16 = 9\tfrac{3}{4} \text{ inches}$$

The main bearing is subjected to shear above the crankshaft, and therefore sufficient metal must be allowed to withstand the shearing stresses. A load of 25 tons, or 50,000 pounds, is transmitted to each bearing, and so with an allowable shearing stress of 2000 pounds per square inch, which leaves a satisfactory factor of safety for cast iron, a minimum shearing area of 50,000 ÷ 2000 or 25 square inches will be required. The main section of the bearings should be 6 9/16 inches long to suit dimension G minus $2F$ (Fig. 2); therefore, the minimum thickness Q_1 (Fig. 8) should equal $25 \div 6.56 = 3\frac{7}{8}$ inches.

The next section of the frame to be considered is the head, taken along the horizontal line Z–Z through the main bearings, as shown in Fig. 9. The method used by the writer is to assume the dimensions of a section and calculate it; if the stresses indicated are not desirable, the section dimensions are changed and the stresses recalculated. The tensile stress should be from 2000 to 2500 pounds per square inch, and the compressive stress preferably from 4000 to 5000 pounds per square inch. Stresses below these values are not desirable from the standpoint of metal economy, while higher stresses do not insure safety and rigidity.

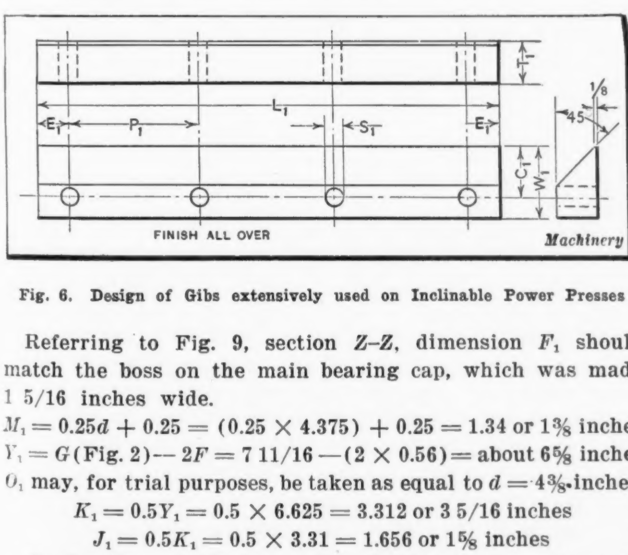


Fig. 6. Design of Gibs extensively used on Inclinable Power Presses

Referring to Fig. 9, section Z–Z, dimension F_1 should match the boss on the main bearing cap, which was made 1 5/16 inches wide.

$M_1 = 0.25d + 0.25 = (0.25 \times 4.375) + 0.25 = 1.34$ or $1\frac{3}{8}$ inches

$Y_1 = G$ (Fig. 2) $- 2F = 7\ 11/16 - (2 \times 0.56) =$ about $6\frac{5}{8}$ inches

O_1 may, for trial purposes, be taken as equal to $d = 4\frac{3}{8}$ inches

$$K_1 = 0.5Y_1 = 0.5 \times 6.625 = 3.312 \text{ or } 3\ 5/16 \text{ inches}$$

$$J_1 = 0.5K_1 = 0.5 \times 3.31 = 1.656 \text{ or } 1\tfrac{5}{8} \text{ inches}$$

R_1 should be made large, say about $0.5d$, so as to avoid complications in casting, or the web section of thickness M_1 may be tapered, making it thicker at the front. Length X_1 may be assumed for trial purposes to be approximately equal to $3d = 3 \times 4.375 = 13\frac{1}{8}$, say $13\frac{1}{4}$ inches.

Before finding the strength of section Z–Z with the assumed figures as a basis, it is necessary to find the center of gravity of the section. The radii may be neglected in the computations, as the variation they may cause would not affect the results appreciably. The center of gravity cannot be determined until the area of each element of the section is multiplied by the distance the center of gravity of the element is located from face f of the section. Thus, the area and area moment of each element are found as follows:

	Area	Area Moment
(a)	$1.312 \times 7.688 = 10.08$	$0.656 \times 10.08 = 6.61$
(b)	$3.063 \times 6.625 = 20.29$	$2.843 \times 20.29 = 57.68$
(c)	$7.25 \times 1.375 = 9.97$	$8.000 \times 9.97 = 79.76$
(e)	$1.625 \times 3.313 = 5.38$	$12.44 \times 5.38 = 66.93$
	Total area = 45.72	Total area moment = 210.98

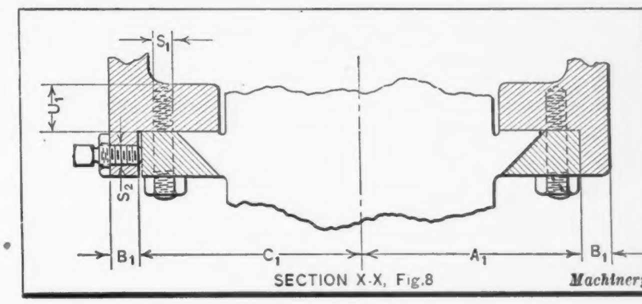


Fig. 7. Section through the Gibways of the Power Press Frame shown in Fig. 8

The distance to the center of gravity of the entire section from face f may now be determined by dividing the total area moment of the elements by the total area of the section. Thus, $210.98 \div 45.72 = 4.62$ inches = the distance to the center of gravity of the entire section from face f. The centers of gravity of the various elements are located from the center of gravity of the entire section as follows:

(a) $4.62 - 0.66 = 3.96$ inches
(b) $4.62 - 2.84 = 1.78$ inches
(c) $8.00 - 4.62 = 3.38$ inches
(e) $12.44 - 4.62 = 7.82$ inches

The moment of inertia I of the entire section may now be calculated by using the general formula

$$I_1 = I_g + (a_1 \times d_1^2)$$

for each element and adding the results. In this formula,

I_1 = moment of inertia of any element in question about an axis through the center of gravity of the entire section;

I_g = moment of inertia of the element about its own center of gravity;

a_1 = area of the element; and

d_1 = distance from the center of gravity of the element to the center of gravity of the entire section.

The moment of inertia of a rectangle with respect to an axis through its center of gravity may be determined by means of the formula

$$I_g = \frac{b_1\ h_1^3}{12}$$

in which

b_1 = width of rectangle in inches; and

h_1 = height of rectangle in inches.

Thus, I_1 for each of the elements in Fig. 9 is as follows:

$$(a)\ I_1 = \frac{7.68 \times 1.31^3}{12} + (10.08 \times 3.96^2) = 159.50$$

$$(b)\ I_1 = \frac{6.63 \times 3.06^3}{12} + (20.29 \times 1.78^2) = 80.11$$

$$(c)\ I_1 = \frac{1.38 \times 7.25^3}{12} + (9.97 \times 3.38^2) = 157.73$$

$$(e)\ I_1 = \frac{3.31 \times 1.63^3}{12} + (5.38 \times 7.82^2) = 330.19$$

Moment of inertia I of the entire section = 727.53

Tensile and Compressive Fiber Stresses

The action of the load on the crankshaft produces a tensile stress on section Z–Z to the left of the center of gravity, and a compressive stress to the right, both of which are due to flexure. In addition, there is a tensile stress distributed uniformly over the section. Before determining these stresses, it is necessary to calculate the tensile and compressive section moduli which are equal to the moment of inertia I divided by the distance from the center of gravity to faces f and m, respectively. Thus the tensile section modulus $= 727.53 \div 4.62 = 157.44$, and the compressive section modulus $= 727.53 \div 8.63 = 84.3$.

The tensile fiber stress due to flexure equals the bending moment of the section divided by the corresponding section modulus, and the bending moment is determined by multiplying the load on each crankshaft bearing by the distance from the center of the crankshaft to the center of gravity. Thus, $50{,}000 \times (2.187 + 4.62) = 340{,}350$ inch-pounds = bending moment. Dividing 340,350 by 157.44 gives 2160 pounds per square inch as the tensile fiber stress due to flexure. The tensile stress uniformly distributed over the section is found by dividing the load on each crankshaft bearing by the area of section Z–Z. Thus $50{,}000 \div 45.72 = 1090$ pounds per square inch. The maximum tensile fiber stress then equals $2160 + 1090$ or 3250 pounds per square inch. This value is greater than the high limit specified in the foregoing, and so the section Z–Z should be more amply proportioned and recalculated. The flexure compressive stress is found by dividing the bending moment by the compressive section modulus. Thus, $340{,}350 \div 84.3 = 4040$ pounds per square inch. This stress would be reduced considerably by subtracting the tensile stress uniformly distributed over the section.

The distance X_1, Fig. 9, may be increased somewhat when the remainder of the head is designed so as to obtain neat and sturdy lines. A tie should be placed between the housings at the rear, as shown in Fig. 8, where it will not interfere with the movement of the slide connection.

Dimensions of the Bolster Plate and Gap

The "shut height" of a press is considered as the distance from the bottom of the slide to the top of the bed, when the slide is at the bottom of the stroke and the connection screw is screwed into the connection as far as it will go. In other words, it is the distance from the bed to the bottom of the slide, stroke down and adjustment up. The "die height" is the distance from the bottom of the slide to the top of the bolster, stroke down and adjustment up.

The thickness of the bolster plate may be made equal to $0.5d + 0.5$ inch to the nearest quarter inch. In this case the thickness would equal $(0.5 \times 4.375) + 0.5 = 2.6875$ or $2\frac{3}{4}$ inches. The bolster plate should match the top of the bed, and in the smaller sizes of presses up to about 5 tons in capacity, it may be held by two bolts. Above this capacity, four or more bolts should be used, depending upon the size of the bolster plate. The bolts should preferably be made the same size as the studs in the connection cap. These were made 1 inch in the preceding article. When parts are to be pushed through the die, it is, of course, necessary to provide a hole through the bolster plate for this purpose.

It has been found that the distance from the center of the crankshaft to the bottom of the slide, stroke down and adjustment up, is 32 inches. Let it be assumed that a die height of 8 inches is desired, that the slide face is allowed to enter the gibs, and that the bolster plate is $2\frac{3}{4}$ inches thick. Then dimension N_1 to the top of the bed will equal $32 + 8 + 2\frac{3}{4} = 42\frac{3}{4}$ inches. H_1 was made 32 inches; therefore the gap height should be $42\frac{3}{4} - 32$ or $10\frac{3}{4}$ inches. If the slide face were not permitted to enter the gibways, the gap height would equal $42\frac{3}{4} - 29\frac{7}{8} = 12\frac{7}{8}$ inches. The depth of the gap should be made a little greater than one-half the width of the deepest die to be used in the press. For purposes of calculation, a depth of $10\frac{1}{4}$ inches will be here assumed for dimension F_2.

Calculating Housing Section Y-Y

A section of one housing, taken on line Y–Y, Fig. 8, is also shown in Fig. 9. The method of calculating this section is similar to that given for the sectio Z–Z. By laying out the preliminary design of the gap, it will be found that a value of about 22 inches for X_2 gives a uniform and neat design. This dimension will therefore be used as a trial value. Y_2 may be made a little less than G, Fig. 2, say, $7\frac{1}{2}$ inches; $M_2 = M_1 = 1\frac{3}{8}$ inches; $O_2 = 0.7Y_2 = 0.7 \times 7\frac{1}{2} = 5\frac{1}{4}$ inches; $K_2 = 0.5Y_2 = 0.5 \times 7\frac{1}{2} = 3\frac{3}{4}$ inches; and $J_2 = 0.5K_2 = 0.5 \times 3\frac{3}{4} = 1\frac{7}{8}$ ins.

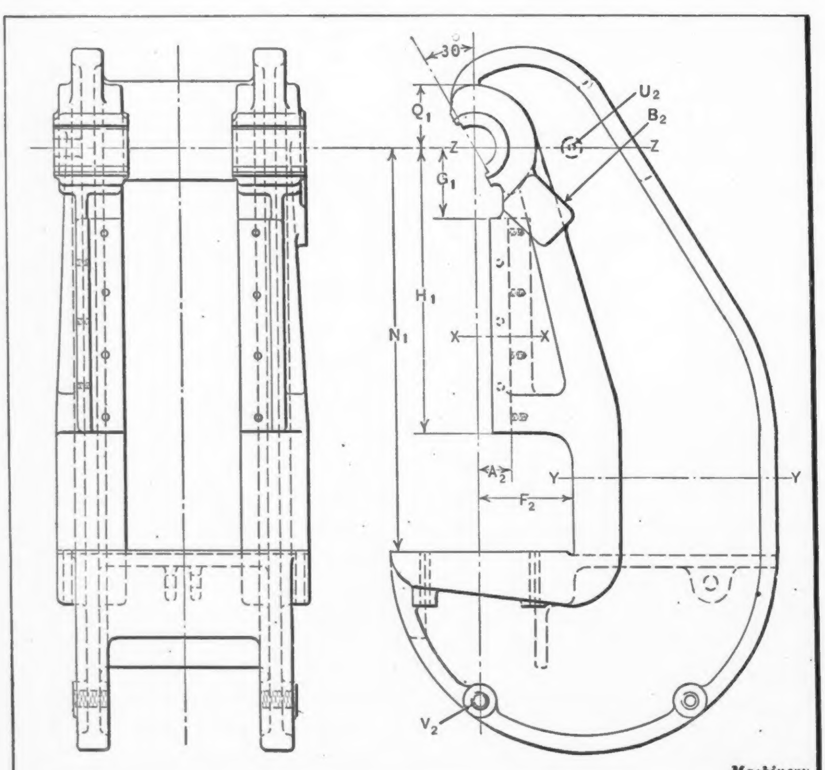


Fig. 8. Detail View of the Frame

The center of gravity of this section is determined by dividing the section into elements h, i, and j, and making the following computations:

Area

(h)	5.25×7.5	$= 39.38$
(i)	14.88×1.38	$= 20.53$
(j)	1.88×3.75	$= 7.05$
	Total area	$= 66.96$

Area Moment

(h)	2.63×39.38	$= 103.57$
(i)	12.68×20.53	$= 260.32$
(j)	21.06×7.05	$= 148.47$
	Total area moment	$= 512.36$

The distance from face k to the center of gravity then equals $512.36 \div 66.96 = 7.65$ inches. The distances from the center of gravity of the various elements to the center of gravity of the entire section are determined as follows:

(h)	$7.65 - 2.63 =$	5.02 inches
(i)	$12.69 - 7.65 =$	5.04 inches
(j)	$21.06 - 7.65 =$	13.41 inches

The moments of inertia I_1 of the elements may now be calculated as follows:

$$(h)\ I_1 = \frac{7.5 \times 5.25^3}{12} + (39.38 \times 5.02^2) = 1082.82$$

$$(i)\ I_1 = \frac{1.38 \times 14.88^3}{12} + (20.53 \times 5.04^2) = 900.38$$

$$(j)\ I_1 = \frac{3.75 \times 1.88^3}{12} + (7.05 \times 13.41^2) = 1269.86$$

Moment of inertia I of entire section = 3253.06

Then the section modulus with respect to face k equals $3253.06 \div 7.65 = 425$, while the section modulus with respect to surface l equals $3253.06 \div 14.35 = 226$. The bending moment equals $50,000 \times (7.65 + 10.25) = 895,000$ inch-pounds. The tensile fiber stress due to flexure equals $895,000 \div 425 = 2100$ pounds per square inch. To this should be added the tensile stress uniformly distributed over the section. This stress equals $50,000 \div 66.96 = 750$ pounds per square inch. Thus, $2100 + 750 = 2850$ pounds per square inch, the maximum tensile fiber stress on the section. This stress is a little high, and so the section should be increased somewhat in area. The compressive fiber stress due to flexure equals $895,000 \div 226 = 3960$ pounds per square inch.

Details of the Frame

The bed member is subjected to bending stresses along an imaginary vertical line drawn downward as a continuation of the face of the gap. It may be calculated as a cantilever beam, loaded at the slide center line. Calculations will show that the distance to the rounded bottom of the housings from the intersection of the top of the bed with the gap face need only be 16 inches if the contour of section Y–Y is maintained. A plate or shelf is cast between the two housings with the top about 1/4 inch below the bed level. This shelf acts as a tie for the frame, as well as a support for the lug which takes one end of the inclining mechanism. It may also serve as a chute to remove parts which are lifted out of the die or knocked out of the punch when the press is inclined.

The diameter of the tapped holes V_2, Fig. 8, which receive studs for clamping the legs to the frame, may be made equal to twice the diameter of the studs used in the main bearing caps, or, in the present case, $2 \times 7/8 = 1\frac{3}{4}$ inches. A boss and stud should be provided at U_2 on the left-hand housing to take the free end of the brake strap. The stud may be the same diameter as the main bearing cap studs, or 7/8 inch. $A_2 = R + M + 1/8 = 1\frac{7}{8} + 1\frac{5}{8} + 1/8 = 3\frac{5}{8}$ inches, R and M being given at the beginning of this article. Pad B_2 should be cast on the frame for attaching the clutch bracket, the size and location of the pad depending on the style of clutch used. The height from the top of the bed to the floor may be made to suit different conditions, the customary height being from 30 to 34 inches.

Flywheel

On a direct-acting press the flywheel should have sufficient energy to carry the ram through the stroke and complete the operation without the speed being reduced over 20 per cent, because if it is reduced more than this, the belt may slip off the wheel. Irrespective of the design of other parts, the press will not have the desired capacity unless the flywheel has the necessary energy to carry the die through the operation without the belt slipping off. Direct-acting presses may be run at various speeds depending upon the distance from the center of the crankshaft to the point where the clutch pin or jaw engages, and upon the quickness with which the clutch can be operated. A press equipped with a rocker-arm or rolling-key clutch can be operated at a higher speed than one equipped with other types of clutches. A block or jaw clutch is especially slow in action.

A flywheel can be designed to have such energy that should there be an overload at a particular point in the stroke, the flywheel will stop. However, suppose the flywheel were intended to stop one inch from the bottom of the stroke in case of an overload, and the overload occurred when the ram was within 1/16 inch of the bottom of the stroke; then the flywheel would not stop and the machine members would be unduly stressed.

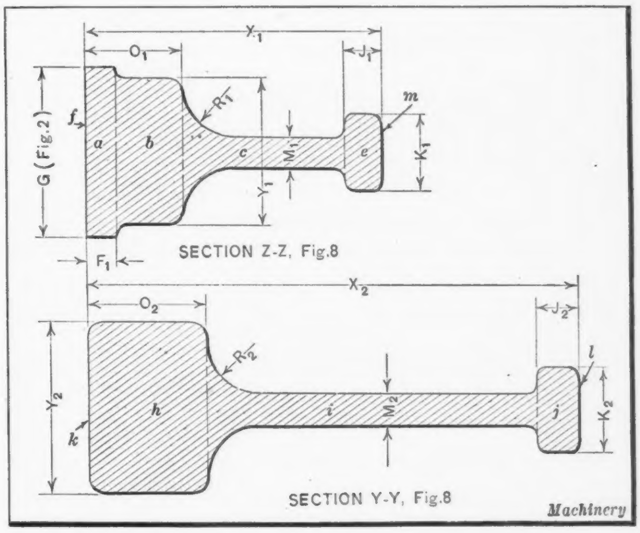


Fig. 9. Sectional Views of the Housings at the Head and Gap, respectively

Direct-acting presses are generally used only for such operations as blanking or shallow drawing, and the flywheel need only have sufficient energy to carry the tonnage through a maximum of about 1/4 inch of stroke. Therefore, for the direct-acting press here considered, the flywheel energy E_2 required to perform an operation through 1/4 inch of the stroke would be:

$$E_2 = 100,000 \times 1/4 = 25,000 \text{ inch-pounds} = 2080 \text{ foot-pounds}$$

Considering a speed of 120 revolutions per minute for the flywheel and a mean rim diameter of 50 inches, the weight of rim required may now be calculated. The velocity V_1 at a point on the mean circumference is determined as follows:

$$V_1 = \frac{50 \times 3.1416 \times 120}{12 \times 60} = 26.18 \text{ feet per second}$$

Counting on a reduction of 20 per cent in the flywheel speed during the working portion of the stroke, the reduced velocity V_2 is determined as follows:

$$V_2 = 26.18 \times 0.80 = 20.94 \text{ feet per second}$$

The weight W of the flywheel rim may now be determined by the following formula, which is given in MACHINERY'S HANDBOOK on page 288:

$$W = \frac{E_1 \times 64.32}{v_1^2 - v_2^2}$$

in which

E_1 = energy in foot-pounds which a flywheel will give out while the speed is reduced from v_1 to v_2;
W = weight of flywheel rim, in pounds;
v_1 = velocity at mean radius of flywheel rim before any energy has been given out, in feet per second;
v_2 = velocity of flywheel rim at end of period during which the energy has been given out, in feet per second.

Then

$$W = \frac{20.80 \times 64.32}{26.18^2 - 20.94^2} = 542 \text{ pounds}$$

If it is desired to have the flywheel carry the tonnage through 1/2 inch of the stroke, the weight of rim should be 2×542 or 1084 pounds.

Before it is possible to calculate the minimum width of face, it is necessary to determine the horsepower required to do the work. Considering that the work is done through 1/4 inch of the stroke, the horsepower can be determined by the following formula:

$$\text{H. P.} = \frac{2000 \times T \times d \times N}{396{,}000}$$

in which

T = tonnage capacity of press;
d = distance through which work is done; and
N = revolutions per minute of flywheel.

Then,

$$\text{H. P.} = \frac{2000 \times 50 \times 0.25 \times 120}{396{,}000} = 7.58 \text{ or } 7\tfrac{1}{2} \text{ horsepower}$$

The foregoing is based on the assumption that the press will be worked to capacity. If the press were to operate at the same capacity 120 times per minute through ½ inch of the stroke, obviously double the horsepower would be used in doing the work.

If a double belt is used on the press, the width required can be determined by the formula

$$W = \frac{1925 \text{ H. P.}}{DN}$$

in which

W = width of belt in inches;
D = diameter of flywheel in inches;
N = revolutions per minute of flywheel; and
H. P. = horsepower consumed in doing the work.

Then,

$$W = \frac{1925 \times 7.5}{50 \times 120} = 2.4 \text{ or } 2\tfrac{1}{2} \text{ inches}$$

The flywheel face should not be less than 3 inches in width for a belt of this size, though it may be greater. Obviously, if it were desired at any time to use increased power, it would be necessary to have a greater width of face and a wider belt. Therefore, the rim may be designed with a wider face and narrower rim to provide for both conditions. A table in MACHINERY'S HANDBOOK, page 291, gives the dimensions of flywheel rims for punches and shears. According to this table, a flywheel 54 inches outside diameter should have a face width of 4¾ inches and a rim depth of 5½ inches. This width of face would allow the use of a wider belt, should it be desirable to increase the power.

Assuming a width of 4¾ inches for the face, the outside and inside diameters of the flywheel may then be estimated by referring to the tables of circumferences and areas in MACHINERY'S HANDBOOK, and applying the weight of cast iron per cubic inch, which is 0.26 pound. The weight of the rim inside of the assumed mean circumference should equal the weight outside of this circumference or $\frac{1}{2} \times 542 = 271$ pounds. The volume of the rim should equal $542 \div 0.26 = 2084$ cubic inches. The area between the outside and inside circumferences equals the volume divided by the width of face or $2084 \div 4.75 = 439$ square inches. The area of a 50-inch diameter circle (the mean diameter) is 1963.5 square inches; then the area corresponding to the inside diameter should equal $1963.5 - 439 \div 2 = 1744$ square inches. This corresponds to a diameter of approximately 47⅛ inches. The area corresponding to the outside diameter should equal $1963.5 + 439 \div 2 = 2183$ square inches, which corresponds to a diameter of approximately 52¾ inches. This would give a weight of 544 pounds with a rim cross-section of 4¾ by 2 13/16 inches.

* * *

AUTOMOBILES IN GREAT BRITAIN

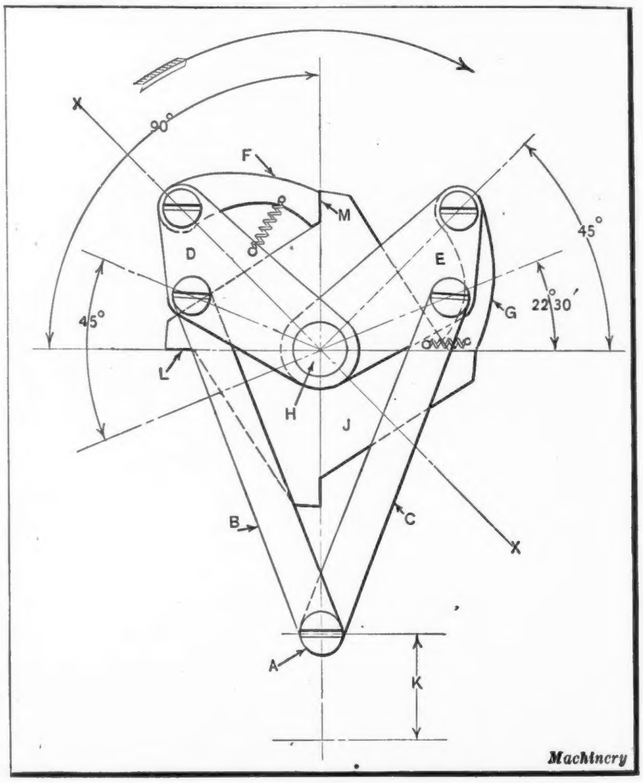
The total number of motor vehicles licensed in Great Britain on November 30, 1922, was approximately 919,000. Of these 294,000 were passenger automobiles used by private owners, 72,000 taxicabs, 159,000 motor trucks, and 352,000 motorcycles, which in Great Britain are included under the general heading of motor vehicles. The license fees and taxes brought in about $50,000,000 to the government. The average tax for passenger automobiles used by private owners is about $80 a year, and for commercial trucks about $100 a year.

INDEXING MECHANISM

By E. E. LAKSO

A 90-degree indexing mechanism which has no idle return throw and which can be operated by a short stroke of the indexing member or lever is shown in the accompanying illustration. The screw or stud A is connected to the part of the machine that produces the indexing motion. The links B and C are connected to the arms D and E which carry the pawls F and G. Arms D and E are free to revolve on the indexing shaft H to which the index-wheel J is fastened.

To impart an indexing movement of 90 degress to wheel J, pawls F and G are given a movement of 45 degrees in one direction and then returned to their normal position. A downward movement of stud A of the right distance, as indicated by dimension K, will draw levers D and E down so that they are rotated through an angle of 45 degrees. This downward movement brings pawl F backward, so that its point will coincide with the center line X–X, and pawl G will move forward until its point also coincides with center line X–X. Thus pawl G indexes wheel J through an angle of 45



Mechanism for producing a 90-Degree Indexing Movement

degrees so that pawl F will catch on the tooth face L of the index-wheel. The return movement of stud A causes pawl F to move forward and to index wheel J the remaining 45 degrees, while the pawl G moves backward to its former position into contact with the face M of the succeeding tooth ready for the next indexing movement.

* * *

The Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce has published a report in which it is pointed out that India now imports approximately $100,000,000 worth of machinery of all kinds annually, of which about 15 per cent comes from the United States. The industrial development of India is indicated by the fact that in the fiscal year 1913-1914, the imports of machinery were valued at about $30,000,000, whereas in 1920-1921 they were more than three times that amount. New enterprises are constantly being started; new capital issues for Indian concerns amounted to about $16,000,000 in the last six months of 1920, as compared with $110,000,000 in the last six months of 1922.

The Manufacture of Buffing Wheels

By BRADFORD H. DIVINE, President Divine Brothers Co., Utica, N. Y., and President of the Metal Finishers' Equipment Association

OWING to the chaotic way the metal-finishing business has grown up since the advent of nickel plating, little or no standard terminology has been adopted. Many branches of the industry making different articles have their own local names for the tools and processes used, and confusion results from this lack of uniform terminology. This is particularly true as to the terminology in use in the United States compared with that in use in England. What is known in America as a polishing wheel is known in England as a polishing bob; and what is known in America as a buffing wheel is known in England as a mop or dolly. The operations involved in the metal-finishing industry are likewise confused in name, but inasmuch as this article pertains to the manufacture of buffing wheels, the question of nomenclature that does not refer to buffing wheels will be left to another article.

In the United States, certain polishing operations that produce the highest luster on bare steel, such as pocket-knife blades, are incorrectly called buffing operations, and the wheels employed for the operation are similarly called buffing wheels. As a matter of fact, the process is polishing with polishing wheels.

Buffing wheels, according to the nomenclature adopted as standard by the Metal Finishers' Equipment Association, are wheels manufactured from disks, either whole or in pieces, of bleached or unbleached cotton or woolen cloth, and are used as the agent for carrying abrasive powders such as tripoli, crocus, rouge, lime, etc., which are mixed with waxes or greases, as a bond. These buffing compositions are applied to the face of the wheel as the metal-reducing or luster-producing intermediary between the buffing wheel and the article being buffed.

Materials Used in Buffing Wheels

During the lifetime of the industry, buffing wheels have been manufactured from a great many varieties of cotton fabric, running all the way from very light flimsy muslins intended for ladies' underwear and other such purposes, up to heavy compact army duck—probably the strongest form of cotton goods that could be used in buffing wheels. Between these two limits, the variety of constructions of cotton goods used in buffing wheels has been almost unlimited. During the early days of the industry and up to the time when the business of manufacturing buffing wheels reached such tremendous proportions that standards were introduced, the predominating idea of most buffing wheel manufacturers was to produce, and likewise that of the users was to purchase, something cheap, and they believed that any kind of cotton cloth would make buffing wheels, regardless of the work it had to do, as long as it could be cut into circles and assembled into sections.

Fig. 1. Turning and assembling Disks into Sections

It was quite the custom, in the early days, to make buffing wheels from remnants and small pieces of indiscriminate texture of cloth too short for sale as cotton piece goods. This idea worked out as a boomerang both to the manufacturer and user. To the buffing wheel manufacturer, it created an idea that quality, standards, and uniformity of production were unnecessary. To the user, it created the idea, roughly speaking, "that buffs were buffs anyhow," and the man who could offer buffs at the cheapest price was the man to purchase from. However, this industry, like all others, had to go through a period of infancy and development until experience demonstrated the necessity for adopting some kind of standard. Furthermore, the time arrived when the buffing wheel manufacturer could not depend solely upon a supply of remnants to meet the constantly growing demand for his product.

In the cotton cloth industry, the lengthwise threads are called the warp, while the cross threads are called the filling or "weft," and the specifications of cotton goods are based on the number of threads per inch in the warp and filling in connection with the width of the goods and the weight per running yard. For instance, 68-64, 3.50 buff is understood to mean a buffing wheel made from a piece of cloth having 68 threads per inch one way, 64 threads per inch the other way, weighing 3.50 yards per pound, when 36 inches wide. Out of this confusion many years ago, there finally arose an understanding, by a sort of mutual consent, that cotton sheeting and shirtings of good weight and body, averaging about 68 by 64 threads per square inch, were more suitable for use in the manufacture of buffing wheels than other kinds of cloth.

Need for Standardization of Wheels

The lack of standardization of buffs produces the varying costs shown in buffing rooms where non-standard goods are used. The Standards Committee of the Metal Finishers' Equipment Association has recently taken up the question of standardizing materials to be used in the manufacture of buffing wheels, and has given it serious consideration in an endeavor to eliminate the confusion in the industry. In connection with this work, the same committee is considering the question of what may and can be produced to the best advantage, as standard diameters. At present, diameters run from 3 to 18 inches in variations of 1 inch. The diameters of buffs in common use were never determined with reference to the widths of cloths commercially available, and consequently there is a great waste of material which someone has to pay for. It is hoped that the committee referred to may be able to work out a set of standards for buffs that will do away with the needless waste, and in this way benefit both the maker and the user.

Fig. 2. "Booking" the Strips for Pieced-sewed Buffs

The additional development of buffing processes requiring harder wheels of a material that would stand up and keep its face to the work, without the edges turning over, brought into use finer count cloth, with the yarns tighter together, woven as high as 92 by 96 threads per square inch.

Inasmuch as this industry was founded on the manufacture of a mechanical tool, using such classes of raw material as it could conveniently find in the market, it soon found itself subject to the vagaries of the manufacturer of cotton cloth; that is to say, a buffing wheel manufacturer would begin to use cloth of a certain style from a certain mill, and in the course of time the mill would cease to manufacture that cloth. Then the manufacturer had to get as nearly the same thing as possible from another mill. This is a condition that has never really been eliminated up to the present time, and consequently there is little or no standard for the raw material used.

The manufacture of buffs finally settled itself down to the use of cotton cloths of the following constructions, not necessarily because they were mechanically advantageous, but because they were for sale in the open market and could be secured. They finally came into common use and thus became, in a sense, standard. They are as follows:

Width, Inches	Yards per Pound	Threads per Square Inch
36	2.85	48 by 48
36	3.75	68 by 64
36	3.50	68 by 64
40	3.20	72 by 68
40	3.40	84 by 80
40	3.20	92 by 84
40	3.05	96 by 88

Canton Flannel—No Specifications

In addition to those mentioned, cloths of many counts and weights have been used in buffs—mostly job lots—and occasionally some permanent make of cloth of a different character has been adopted by some manufacturer, but such goods usually enjoyed a short life in this industry. The styles of cloth enumerated in the table are those that are conceded, by the majority of the buff manufacturers and by the buff users, as the nearest to a standard that may prevail today. These goods are standard as to classification of construction only, but there are a great many other things that enter into the manufacture of cotton cloth causing varients. For instance, of two mills making cloth of the same identical specifications of count, width, and weight, the cloth produced by one mill may be much more valuable in a buffing wheel than that produced by the other.

An essential economic requirement in the manufacture of buffs is that practically the entire area of cloth purchased must be cut and manufactured into disks and sold as buffing wheels. The exact size of the buffs and the quantities of each into which the cloth is to be cut, not being known when the cloth is purchased, the ultimate cutting often produces a loss instead of a profit. Therefore, buffing wheel manufacturers realize that economical sizes must be adopted, and they must confine themselves to such grades of cloth as can be used for the different buffing processes, and permit them to sell as buffs practically all the material they purchase in the form of cloth. The desire of many buff manufacturers to put something "special" on the market in the line of a non-standard or a cheap buff cloth, in order to cut prices or for some other reason, has invariably, for the reason stated, resulted in their bankruptcy.

As conditions exist today in the manufacture of cotton goods, the buff industry is still up against the hazard of being unable to purchase an absolutely uniform standard run of cloth from any one mill. Strikes, changes in policy of mills, change in mill ownership, changes in the character of cotton produced in various years, and other contingencies cause this condition, and the buff manufacturer has no remedy. All these things lead to contentions between the buff manufacturer and the consumer, and usually result in claims that certain lots of buffs are not up to standard. The buff purchaser and user will be in a better position if he will sit down with the buff manufacturer, and learn something about the conditions and the difficulties encountered in the manufacture of buffs.

Importance of Aging the Buffs

A condition exists in the manufacture of cotton cloth over which no one but Father Time has any control, but it has considerable influence upon the value of any particular shipment of buffs to the user. That condition is the effect of the drying out and aging of the cloth. When cotton yarn is woven into sheetings, the weave shop atmosphere must be very humid; otherwise the yarns will twist and snarl, and weaving will be impossible. The cloth, therefore, coming direct from the loom, is moist and damp, and it takes a long time for this moisture to dry out and the cloth to harden properly. Buffing wheels will show much longer wear, all other conditions being equal, if the sheetings or buffs can be kept in stock by the manufacturer or user, in a cool dry place, several months before being used. This period will allow the cloth to harden and the cutting power of the buff will be increased.

In the last analysis, the user of the buffs is safer if he buys his buffs far enough in advance to permit thorough drying and aging in his own storehouse. The manufacturer endeavors to dry and age the cloth thoroughly before cutting it into buffs, but should a shipment be made to the consumer during rainy weather the cloth may absorb enough moisture to soften it and return it to its original "green" condition. Then if the consumer is low on his buff stock and has to use the new shipment before giving it a chance to dry and age again, the buffs will show a decided depreciation in efficiency. The reason for this is very often not understood by the consumer, with the result that the blame is wrongly placed on the buff.

Converting the Cloth into Buffs

The common method of converting cloth into buffs is to cut and assemble eighteen or twenty disks together, then put a row of sewing around the center hole, forming what is known basically in the industry as a "section." Twenty-ply is the standard for a section, although a great many sections are made eighteen-ply. This eighteen-ply standard came into being some years ago through unscrupulous competition. Twenty-ply was the original standard, but several concerns, thinking to gain an advantage, sold goods at less than the twenty-ply price, using eighteen layers, and finally it became a secondary standard, but it should not be allowed to continue to exist.

Buffing wheels are made up from the unit of sections assembled together in any desired number, or to form any required width of face. There are three distinct types of buffing wheels: First, loose buffs, made up of full disks of cotton or wool cloth, sewed together into sections only around the center hole, for convenience in handling; second, full-disk sewed buffs, which are spirally or concentrically sewed over the entire surface between the center hole and the periphery; third, pieced-sewed buffs made of pieces too small to be cut into full disks. These pieces are assembled together, as will be described later, and held in position by spiral or concentric sewing, the same as the full-disk sewed buffs.

Loose or Open Buffs

A loose or open buff, as the name implies, is one that is loose or open at the cutting or buffing surface. Consequently it has to be made of full disks of cloth, which are sewed together in standard sections of eighteen- or twenty-ply, with only a single sewing around the arbor hole at the center. They are made in the different grades of cloth referred to previously.

In the actual conversion of the cotton cloth into loose or full-disk buffing wheels, the following processes are used. The cloth is received either in bales or in rolls. Some manufacturers using the rolls place eighteen to twenty rolls in a rack and pull the cloth from all the rolls at one time on a laying-out table, where the edges are squared up. From this table the cloth passes through the cutting presses, where the disks are cut out.

Other manufacturers take the folded piece goods from the bale and lay them out on a "booking" or laying-out table, by means of a laying-out machine, which travels back and forth lengthwise on the table and lays the cloth, layer upon layer, until ninety or one hundred layers have been put into what is called a "book." The function of this machine is to square up the edges of the cloth of one layer with the corresponding edges of the preceding layers, so that the die-cutting can be carried to the edges of the book, making all the disks full circles. These books, when completed, have the edges clamped into position, so they may not be disturbed by moving the book, and are passed through the cutting press, where the disks are cut out, as shown in Fig. 3. The dies used for cutting the disks are usually compound; that is, they cut the center hole and the outside edge at the same time. The dies for the center hole are made interchangeable, and any sized center hole can be produced in combination with any outside diameter.

From the cutting press the disks are moved to a sorting and disk turning table. Here damaged disks are sorted out, and the perfect ones are assembled into buffing sections, which are eighteen or twenty layers thick, as may be desired. (See Fig. 1.) In assembling, the disks are placed on a center pin of suitable size, and each disk or pair of disks is turned in relation to the preceding disk or pair so that the threads in each lie in a different relative position from those in the neighboring disks. This insures uniform wear on the face of the buff. As soon as the proper number of layers are assembled, the buff section is moved to a sewing machine, which sews usually one row of sewing around the center hole. The buff is now finished, except for the trimming of any irregularities on the outside edge, and upon being branded is ready for shipment.

Full-disk Sewed Buffs

A full-disk sewed buff is one that is made of full disks of cotton or woolen cloth in standard sections of eighteen- or twenty-ply, sewed spirally or concentrically between the center hole and circumference of the buff. This sewing gives the buff section greater stiffness and resistance to bending, when in contact with the work. The stiffness or body of the buff depends largely upon the distance between the rows of sewing, the length of the stitch and the tension of the stitches. In standard sewing, the rows are 1/4 or 3/8 inch apart. The length of the stitch varies with different manufacturers from 3/16 to 1/2 inch, but the common form of stitch is about 3/16 to 1/4 inch long.

The sewing is accomplished with special sewing machines, developed for this purpose (see Fig. 4). Usually two needle machines are used, and the sewing is done automatically. The movement of the sewing machine foot turns the buff around, operates a worm screw, rack and pinion, or other device, which moves the buff under the needles of the machine so that the sewing is guided automatically spirally or concentrically over the entire surface of the buff.

Practically all pieced-sewed buffs manufactured by large makers are sewed in the same type of machine and with what is known as a lock stitch, that is, a stitch that will not ravel or pull out. The chain stitch was formerly used in sewing buffs, but it has the objection of unraveling very easily. The sewing of buff wheels is an interesting operation. Let the reader take a wire nail and try to drive it through a buff wheel section; and then imagine two slender sewing machine needles being driven down through 1/4 to 3/8 inch thickness of cloth at a speed of about one thousand stitches a minute—and some idea of the difficulty of this operation may be obtained.

A pieced-sewed buff is one in which all the plies or layers, except the outside layers, are in the form of pieces

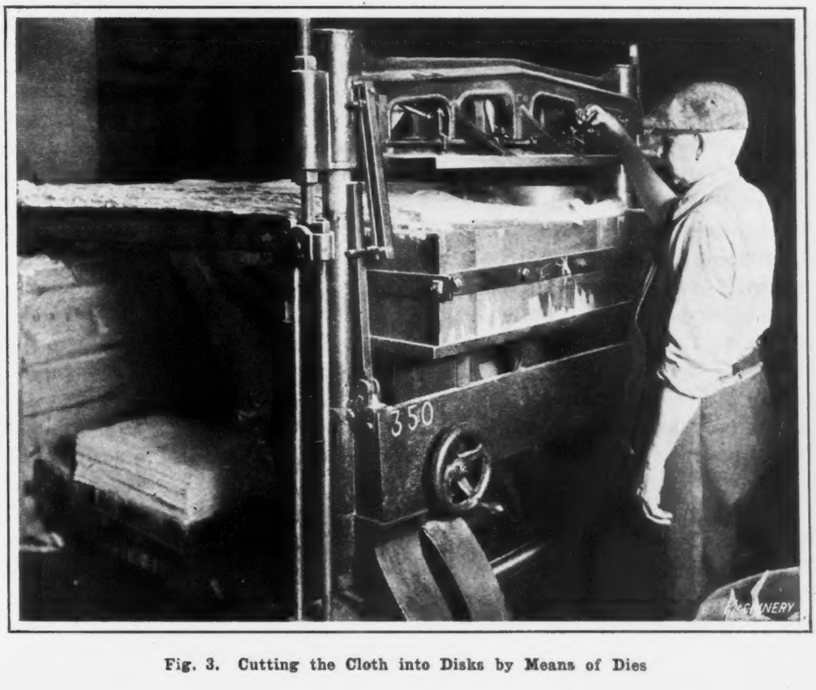


Fig. 3. Cutting the Cloth into Disks by Means of Dies

too small to cut into full disks, and the whole assembly is sewed together with concentric or spiral rows of sewing. The standard materials used in these buffs are bleached and unbleached cotton cloths, while special forms are made of so-called "fancy" or printed goods, khaki, and a variety of textures.

Weight is the common basis for the unit standard per section in buffs of this type, rather than ply, for the reason that the form and size of the pieces of cloth vary greatly, and it is commercially impossible to manufacture the sections with the same number of ply in each. They are sold on the basis of bulk weight, as the sections are likely to vary somewhat in weight.

Strip and Wedge Styles of Pieced-sewed Buffs

Pieced buffs are of two types of construction, known as the strip and the wedge styles. The wedge type was the original construction, but later the strip style was introduced. This style was patented, and has to a large extent superseded other forms. In the strip construction two methods of assembling are employed: For a buff to be 14 inches in diameter when finished, the strip may be cut, by one method, to a length of 29 inches. A laying-out board, with raised edges, is provided, and in this is placed one piece of cloth 29 inches square for one of the covers or outside layers. On this cover will be laid a layer of strips, arranged edge to edge, and with the edges as evenly matched as is possible. Then another layer of strips crosswise and so on until the proper thickness for a buff section is built up. The top cover is then laid in place. This 29-inch square will be cut into four buff sections, each 14½ inches in diameter, with a very small hole in the center. The sections are sewed spirally or concentrically, after which the outside diameter and the center hole are cut in a cutting press with a compound die, finishing the manufacturing operations.

Fig. 4. Automatic Sewing Machine for sewing Buffs

The other form of strip construction is known as the "booking" form. This consists of assembling the strips on a table arranged with raised sides and ends, forming a box, of a suitable length and width to produce a certain definite number of sections. (See Fig. 2.) In this process, a full sheet of cloth is laid on the table, a layer of strips lengthwise, with the edges matched, on top of it, next a layer of strips crosswise and so on until the proper thickness is built up. The top sheet, or the cover, is then put in place and the edges of the entire mass fastened together to hold the strips in place during the moving of the "book" to the cutting press. From this point on, the process is exactly the same as for the buff made in the 29-inch square form.

In the segment or wedge buff, the pieces of material are cut out by means of a die into wedge-shaped segments, with two, four, six, or eight segments to a circle. A form is provided, usually a wooden block or a pan with raised edges. A full disk is deposited in the form for one cover of the buff, then a layer of the wedges is laid on this cover, carefully matched, and succeeding layers are built up until the requisite thickness is obtained. In the arrangement of the layers, the joints are "broken," as one would say in bricklaying, to avoid several joints coming in the same place. After the top cover is in position, the buff is ready for cutting and then for the sewing machine, subsequent operations being the same as for the 29-inch square. During the process described, great care must be taken by the operator to arrange the goods so that the buff will be as well balanced as possible. In some makes of the strip form of buff, the goods are so closely graded and matched for uniformity that a practical working balance is secured. Buffs made from graded cloth, of course, give more satisfactory performance than those not graded, chiefly on account of the uniformity permitting better standards in the cost of the goods being buffed.

Pieced-sewed buffs were originated in an endeavor to utilize the small corners left over after cutting full-disk buffs from cotton sheeting. It will be realized that when three circles intersect, or meet, there is a triangular area surrounded by the circles. These triangles were cut into wedge-shaped segments, which were arranged edge to edge in layers with the edges of each layer "breaking joints" with those of the next layer. Then with a full disk at the bottom and another on top, the whole was sewed together. For some kinds of work, this proved to be a very acceptable form.

As time passed and the business grew in volume, the supply of these triangles could not keep up with the demand, and it became necessary to resort to the use of small pieces of cotton cloth from cotton mills. The principal source of supply of such small pieces occurs in the waste cloth produced by tearing out oil-spotted or otherwise damaged parts from the cloth produced. These "rags" are usually in the form of strips. These were laid out smoothly and cut into wedge-shaped segments, but later on, a patent was secured by one concern for assembling the strips themselves into squares with each layer at right angles to the next one and with a full piece top and bottom, and a better form of construction was secured. However, both wedge-shaped segments and the strip construction are in existence today in a large way.

There are certain inherent difficulties involved in the manufacture of pieced-sewed buffs, the principal one being to secure a permanent supply of uniform goods of a quality satisfactory for buffing wheel purposes. During periods of excessive business activity, such as we had in the years 1919 and 1920, it is usually impossible for any manufacturer of buffing wheels to supply pieced-sewed buffs of a uniform quality in sufficient quantities to the trade, with the result that standards are somewhat destroyed. This condition happens in every business cycle where the demand for pieced-sewed buffs exceeds the producing capacity of cotton mills, so far as remnants are concerned. In other words, the pieced-sewed buff business is not established on a proper basis. It does not control its own supply of raw materials, and it is to be hoped that a form of buffing wheel may be developed that will correct this difficulty.

The question has often been asked why full-disk buffs are usually made of unbleached goods, while the pieced-sewed buffs are made of bleached goods. The answer is that unbleached goods are used in full-disk buffs because that is the way the goods are received from the mills, and bleaching does not produce an article sufficiently superior to warrant the cost of doing this. The reason that pieced-sewed buffs are usually made of bleached goods is because the small pieces are the remnants detached from the large bolt or cuts of cotton cloth or by-products of mills fabricating bleached cotton cloth into merchandise, and there is only a limited supply of unbleached material suitable for buffs. In other words, there are practically no unbleached remnants on the market. In the pieced-buff production, about 2 per cent of the buffs are unbleached and 98 per cent bleached.

It will be appreciated that the question of balance is very important, in the manufacture of pieced-sewed buffs, when it is remembered that buffing wheels are operated at the high speed of ten to twelve thousand peripheral feet per minute. Therefore, it is essential to obtain the most perfect balance possible. This is very difficult, in view of the shape of the pieces, their irregularity, and the varying weights of the cloth used. Another important point is to make the section as even in thickness throughout the area as possible, and here again the varying character of the goods makes this difficult.

Special Forms of Buffing Wheels

While the preceding facts cover the more common and standard types of buffing wheels, there are many special forms of buffing wheels used. Woolen cloth, which has previously been referred to, is used in what is known as hand-sewed buffs; these buffs are employed almost entirely on precious metals. The woolen cloth has to be absolutely pure—free from cotton—as the buffing operation of pure woolen cloth at slow speeds on precious metals must lay down the metal and produce the luster, without tearing any of the precious metal away. In that sense the action is quite different from high-speed, faster cutting cotton buffs used on the coarser metals. Canton flannel is another material used in various weights and constructions having no particular standard, which is employed almost exclusively in the form of hand-sewed buffs on sterling silver. Sheepskin buffs are also used, the skins being soft and flexible.

All of these three materials are made up in the so-called "hand-sewed" wheel, in which instead of sewing eighteen or twenty layers of the material together into sections, the entire thickness of the wheel, from 3/4 inch up to 3 inches, is sewed through and through by drilling holes and sewing by hand with baling needles, using a special heavy tough twine. This form of sewing is always done in concentric circles, each circle being complete in itself and not connected with the other circles. The reason for this is that the buff operates at slow speed, and the sewing is required to hold the layers of material together into the unit form of a wheel, so that as the wheel wears down to the first row of sewing, that row, being independent of the next row, can be cut out without opening up or destroying the buff.

The center of this jewelers' form of buff is hardened with shellac or glue to permit the wheel to be used on the small taper screw arbor usually employed in jewelers' work. The sheepskin buffs sometimes are left open, having only one row of sewing around the center like a loose buff, but are never made up in the form of sections. They are always made in complete units.

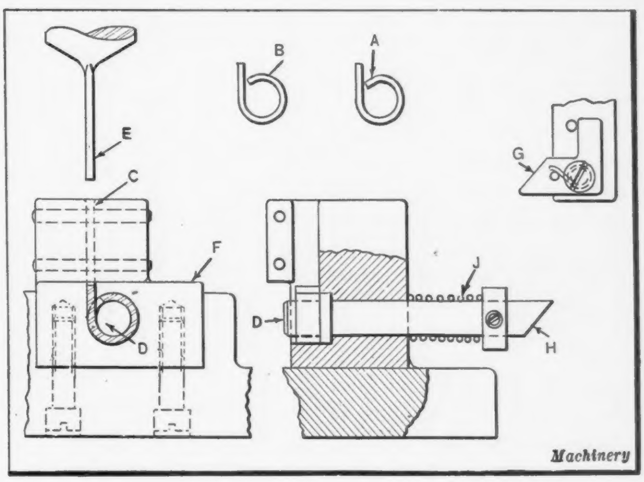
Another form of buffing wheel is the solid felt wheel, which has a peculiar advantage in the solidity of its face, when used on relief work, such as nameplates or ornamental plates on stoves, where it is desired to buff the top of the work and leave the recessed surface in the original frosted silver color of the unbuffed nickel.

CURLING DIE WITH ARBOR

By D. A. NEVIN

The usual design of curling die for forming hinges, rings, and a variety of curled parts leaves the work with a flattened portion in the loop, as shown at *A* in the accompanying illustration. This inaccuracy is permissible in some cases, but it is frequently desired that the ring be nearly perfect, as shown at *B*. To accomplish this, the work should be curled around an arbor. The die shown in the illustration is provided with such an arbor. A positive means of ejecting the work is also embodied in this die.

The straight blank is placed in the slot at *C*, which encloses it, and it is curled around the arbor *D* when the punch *E* descends. On the up stroke of the press, the trigger *G* moves upward with the punch, and comes in contact with the cam end *H* of arbor *D*, thus ejecting the work from the die-block *F*. The ring opens sufficiently to allow it to be stripped from the arbor when the latter is returned to the position shown, by the action of the spring *J*. The ring only needs to open a few thousandths inch in order to be stripped from arbor *D*, provided a sharp corner is left on the edge of the hole which encloses the work. On the down stroke of the



Curling Die provided with Arbor and Stripping Device

press, the trigger *G* snaps over the cam end *H* of arbor *D*. A variety of work can be accurately curled in a punch and die of this design, including tubes of short lengths. Some parts, however, may require a second operation for closing the seam.

* * *

PREVENTION OF CAR SHORTAGE

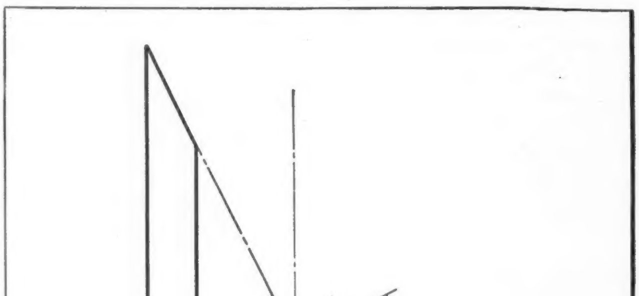
Secretary Hoover is asking the cooperation of all executives in the industries in preventing car shortage and freight embargoes during the coming fall and winter. The principal methods by which the industries can assist in preventing an overloading of the railroad facilities next winter are by ordering and storing their winter coal between now and September 1; by loading all cars to full capacity; by promptly loading and unloading cars; by reducing reconsignment shipments; and by never demanding more cars than can be promptly used. It is estimated that if all the industries would observe this request the railroads would be able to increase the effectiveness of the present equipment to an extent that would be equivalent to 3000 new locomotives, 300,000 cars, and a 10 per cent addition in track mileage and terminal facilities.

The most serious check to our present industrial activity may come from a shortage of railroad facilities. It is therefore to the interest of every manufacturer to do his share in preventing this shortage from becoming more serious than it otherwise would be.

Computing Pitch of Bevel Gears

By GEORGE F. NORDENHOLT, Assistant Professor in Mechanical Engineering, Lehigh University, Bethlehem, Pa.

BEVEL gears, in order to be kept in accurate alignment must be properly proportioned in respect to pitch, width of face, and slant height of pitch cone. The methods used in determining the ratio of face width b (see accompanying illustration) to the circular pitch, are practically the same as in the case of spur gears. However, in designing bevel gears there is the added restriction that the face width should not exceed a certain proportion of the slant height K of the pitch cone. The reason for this is readily understood when we consider the fact that the teeth become thinner as they approach the apex of the pitch cone. Should the tooth become too thin at the inner end in proportion to its mean thickness, it would break if the load were momentarily concentrated at the thin end. The ratio of face width to mean circular pitch is usually 2½ or 3, and the face width should not exceed one-third of the slant height of the pitch cone.



Method of calculating "Formative Tooth" of Bevel Gear

The pitch of bevel gears may readily be calculated by applying Tredgold's approximation and then computing the pitch of the "formative spur gear." The method of applying Tredgold's approximation is shown in the illustration. The line *ed* is drawn perpendicular to the line *Od* of the pitch cone, and produced until it intersects the axis of the pinion at *e*. The profile of a spur gear tooth based on a pitch radius equal to *ed* will be very nearly the same as the actual profile of the bevel gear tooth at point *d*, assuming that the pitch is the same in both cases. If the load on the tooth and its strength are both assumed to be proportional to the distance from the apex of the pitch cone, then we may consider the whole load as acting at the mid-point of the tooth face, which will be at the mean radius of the pinion. The required pitch of the corresponding formative tooth will then be the pitch of the bevel pinion at the mid-point of the tooth, that is, the mean pitch. Formulas (1), (2), and (3) of the present article appeared also in April, 1922, MACHINERY in an article entitled "Methods of Computing Pitch of Spur Gears." However, for convenience these formulas are given here also.

$$\frac{cz^2}{4\pi^2} = \frac{r^2 f \times (b \div p)}{P} \tag{1}$$

$$p^2 = \frac{2\pi cPr}{zf \times (b \div p)} \tag{2}$$

$$p^8 = \left(\frac{(2\pi c \div \sqrt[3]{720}) \times Pr}{(b \div p) \times S}\right)^3 \times \frac{n}{z^2} \tag{3}$$

In the foregoing formulas,

c = a constant, the value of which depends on the number of teeth;
r = radius of pitch circle of pinion;
b = width of tooth;
p = circular pitch;
f = allowable tooth stress;
S = allowable initial tooth stress for peripheral velocities up to 1 foot per second;
P = load on tooth;
z = number of teeth in pinion; and
n = revolutions per minute of pinion.

Formula (1) is applicable when the diameters of the gears are known. Formula (2) applies when the diameters are unknown, and the peripheral velocity of the gear is not more than 1 foot per second, while Formula (3) applies when the diameters are unknown, and the peripheral velocity is greater than 1 foot per second. These formulas may be used to find the pitch of the "mean formative spur gear" of the bevel gear pinion. The method may best be explained by working out examples. Only bevel gears having shafts meeting at right angles will be considered, but by substituting the proper trigonometrical functions the method can be used for any shaft angle. In finding the pitch of the "mean formative spur gear" of bevel gears having their shafts at right angles, two cases must be considered. In the first, the diameter of one of the gears is specified, and in the second, no diameter is given.

Solution when Diameters are Specified

Example—Four horsepower is to be transmitted by a pair of bevel gears. The shafts meet at right angles and the outer pitch diameter of the pinion is to be 8 inches. The pinion is to run at a speed of 100 revolutions per minute, while the other shaft is to have a speed of 50 revolutions per minute. The problem is to find the circular pitch.

In this problem all computations will be based on the pinion, as it has the weaker tooth. Assuming $b = K \div 3$, it is evident from an inspection of the similar triangles involved that the mean pitch radius will be 5/6 that of the outer radius or $5/6 \times 4 = 3.33$ inches. Assuming that the

full load is acting at the mean radius, we have

$$P = \frac{63{,}025H}{rn} = \frac{63{,}025 \times 4}{3.33 \times 100} = 760 \text{ (approximately)}$$

where H = horsepower transmitted;
r = mean radius of pinion; and
n = number of revolutions per minute.

The mean peripheral velocity will then be found by the formula,

$$\frac{2\pi rn}{720} = \frac{2\pi \times 3.33 \times 100}{720} = 2.9 \text{ feet per second}$$

Assuming an allowable initial unit stress of 6000 for velocities up to 1 foot per second, and using Reuleaux's formula, we have

$$f = \frac{6000}{\sqrt[3]{V}} = \frac{6000}{\sqrt[3]{2.9}} = 4200$$

Taking $b \div p$ as 3 and, for the formative gear, applying Formula (1), we have,

$$\frac{cz^2}{4\pi^2} = \frac{rf \times (b \div p)}{P}$$

where r should really be considered as the radius of the formative gear.

However, it will be noticed that the mean formative radius is only slightly larger than the mean radius of the bevel pinion. If the mean radius of the pinion is used for r in the foregoing formula, it will result in a smaller number of teeth. But these teeth will be on a smaller radius; hence the difference in pitch will be very slight when we assume that the formative radius and mean radius are equal. In any case, the error is on the side of safety, so in order to simplify matters, we will carry through the assumption, and let $r = 3.33$ inches.

Hence

$$\frac{cz^2}{4\pi^2} = \frac{(3.33)^2 \times 3 \times 4200}{760} = 184 \qquad (4)$$

From the table accompanying the article previously referred to, we see that this value corresponds to 26 teeth; hence the diametral pitch of the formative gear would be

$$\frac{26}{2r} = \frac{26}{6.66} = 3.90$$

This gives a circular pitch of

$$p = \frac{\pi}{3.90} = 0.8$$

which will be the mean circular pitch of the bevel gear.

The slant height of the pitch cones will be:

$$\sqrt{R^2 + r_1^2} = \sqrt{16 + 64} = 9 \text{ inches, approximately.}$$

As $b \div p$ was assumed as 3, b will equal $3p = 2.4$ inches.

This is less than $K \div 3 = \frac{9}{3} = 3$. Hence the tooth width is within the assigned limits as regards its proportion to pitch and slant height of the pitch cone.

The question now arises as to what would be the procedure had b come out greater than $K \div 3$. To illustrate this, we will work out the same example, assuming that it is required to transmit 7 horsepower instead of 4. Then the load P would be 7/4 as great, and as all other quantities remain the same,

$$\frac{cz^2}{4\pi^2} = \frac{184 \times 4}{7} = 105$$

According to the table previously referred to, z would equal 19, and the diametral pitch would be $19 \div 6.66 = 2.85$, the corresponding circular pitch being $\pi \div 2.88 = 1.10$, which would be the mean circular pitch of the bevel gears.

As $b \div p$ was taken to be equal to 3, b would equal $3 \times 1.10 = 3.3$ inches. This is somewhat greater than $K \div 3 = 3$. If this is not desirable, we may recalculate, using a smaller value of $b \div p$, say 2.5. Then as this would be the only quantity changing its value

$$\frac{cz^2}{4\pi^2} = 105 \times \frac{2.5}{3} = 87.5$$

According to the table, the corresponding value of z is 17. The diametral pitch of the formative gear then equals

$$\frac{17}{6.66} = 2.55, \text{ and } p = \frac{\pi}{2.55} = 1.23$$

As $b \div p = 2.5$, $b = 2.5 \times 1.23 = 3.08$, which, though slightly larger than $K \div 3$, would probably be permissible.

The foregoing method ignores the fact that should the calculations for b result in a value less than $K \div 3$, the mean radius would be greater than 5/6 the outer radius. The resulting error, however, is so small as to be practically negligible.

Solution when No Diameters are Specified

Before proceeding with an example in which no diameters are specified, we will develop a formula to determine the proper value of $b \div p$ so that b will not be more than $K \div 3$. We have

$$K = \sqrt{R^2 + r_1^2}$$

But

$$R = \frac{tZ}{2\pi} \text{ and } r_1 = \frac{tz}{2\pi}$$

where t equals circular pitch at the outer diameter, and Z, number of teeth in the larger gear.

Hence

$$K = \frac{t}{2\pi} \times \sqrt{Z^2 + z^2}$$

Dividing and multiplying the terms under the radical by z^2,

$$K = \frac{t}{2\pi} \times \sqrt{z^2\left(\frac{Z^2 + z^2}{z^2}\right)} = \frac{tz}{2\pi} \times \sqrt{a^2 + 1}$$

where a is the velocity ratio $Z \div z$.

Dividing both sides by 3,

$$\frac{K}{3} = \frac{tz}{6\pi} \times \sqrt{a^2 + 1}$$

But $K \div 3$ is the maximum value for b; hence

$$b = \frac{tz}{6\pi} \times \sqrt{a^2 + 1} \text{ or } \frac{b}{t} = \frac{z}{6\pi} \times \sqrt{a^2 + 1}$$

which will be the ratio of the width to the pitch at the outer diameter. The mean pitch is 5/6 the outer pitch when $b = K \div 3$; hence by dividing both sides by 5/6 and substituting for $5/6 \times t$ its value p,

$$\frac{b}{p} = \frac{z}{5\pi} \times \sqrt{a^2 + 1}$$

which is the ratio of b to the mean circular pitch, when $b = K \div 3$. With a and z known, this value of $K \div 3$ can readily be figured. If it comes out equal to, or less than, the desired ratio of $b \div p$, the computed value of $b \div p$ should be used in further computations, and b will then equal $K \div 3$. If it comes out greater than the desired ratio, the latter ratio should be used, and b will be less than $K \div 3$.

Example—Two horsepower is to be transmitted by a pair of bevel gears, the shafts meeting at right angles. The gear shaft is to make 10 revolutions per minute and the pinion shaft 20.

Assume 15 teeth for the pinion and 30 teeth for the gear, which will give a velocity ratio of 2 as desired.

Then

$$\frac{b}{p}=\frac{z}{5\pi}\times\sqrt{a^2+1}=\frac{15}{5\pi}\times\sqrt{4+1}=2.12$$

and b will equal $K\div 3$.

As the velocity will probably be less than 1 foot per second, Formula (2) should be applied. From the table of constants the value of $2\pi c$ for 15 teeth $=80.4$. We will assume that the gears are steel and that the allowable unit stress is 16,000 pounds per square inch.

$$Pr=\frac{63{,}025\times H}{n}=\frac{63{,}025\times 2}{20}=6300 \text{ (approximately)}$$

Then

$$p^2=\frac{2\pi\, c\, Pr}{(b\div p)f}=\frac{80.4\times 6300}{2.12\times 16{,}000}=14.9$$

and

$$p=2.46 \text{ inches}$$

The mean circumference $=15\times 2.46=35.4$ inches $=3$ feet, approximately. The peripheral velocity will equal $\frac{3n}{60}=\frac{3\times 10}{60}=0.5$ feet per second, which, being less than 1, shows that it was correct to use Formula (2). Had the peripheral velocity been found to be greater than 1 it would have been necessary to recalculate, using Formula (3). A typical problem in which the mean peripheral velocity is found to be greater than 1 is as follows:

Example—Ten horsepower is to be transmitted between two shafts meeting at right angles, one shaft making 200 revolutions per minute and the other 50 revolutions per minute. In this problem we will assume 18 teeth for the pinion. Then for the limiting value of $b=K\div 3$, we would have

$$\frac{b}{p}=\frac{z}{5\pi}\times\sqrt{a^2+1}=\frac{18}{5\pi}\times\sqrt{16+1}=5.06$$

Hence a maximum value of $b\div p=3$, will make b less than $K\div 3$. As the velocity will probably be greater than 1 foot per second, we will apply Formula (3).

From the table of constants $\frac{2\pi c}{\sqrt[3]{720}}$ for 18 teeth $=8.13$.

In this case we will assume that the gears are cast iron and that the allowable unit stress in 6000 pounds per square inch.

$$Pr=\frac{63{,}025\ H}{n}=\frac{63{,}025\times 10}{200}=3150$$

$$p^8=\left[\frac{(2\pi c\div\sqrt[3]{720})\times Pr}{(b\div p)\times S}\right]^3\times\frac{n}{z^2}$$

$$=\left(\frac{8.13\times 3150}{3\times 6000}\right)^3\times\frac{200}{324}=1.788$$

$$p=\sqrt[8]{1.788}=\sqrt[4]{1.33}=\sqrt{1.15}=1.07$$

Therefore 1.07 is the mean circular pitch.

The mean circumference will be $1.07\times 18=19$ inches $=1.5$ feet, approximately. The peripheral velocity will equal $\frac{1.5\times n}{60}=\frac{1.5\times 200}{60}=5$ feet per second, which being greater than 1 shows that it was correct to use Formula (3). Had the peripheral velocity been found to be less than 1 it would have been necessary to recalculate, using Formula (2).

It will be noticed that in these last two solutions where no diameters are specified, the numbers of teeth and the radii of the bevel gear and formative gear were assumed to be equal. However, as in the case where diameters were given, the error is very slight and is on the side of safety. The greatest error from this cause will be in figuring miter gears, in which case the pitch calculated will be about 4 per cent greater than if the calculations were based on the formative radius and number of teeth. However, for all practical purposes, the methods outlined above are sufficiently accurate.

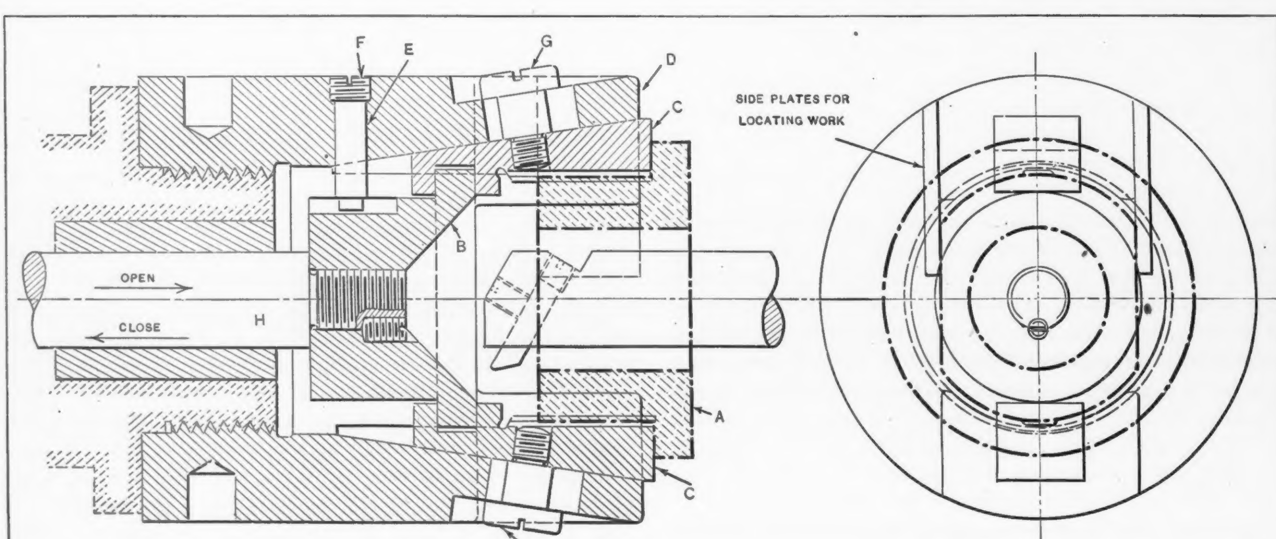
* * *

CHUCK FOR HOLDING ROUND WORK WHILE BORING

By VICTOR HUGO

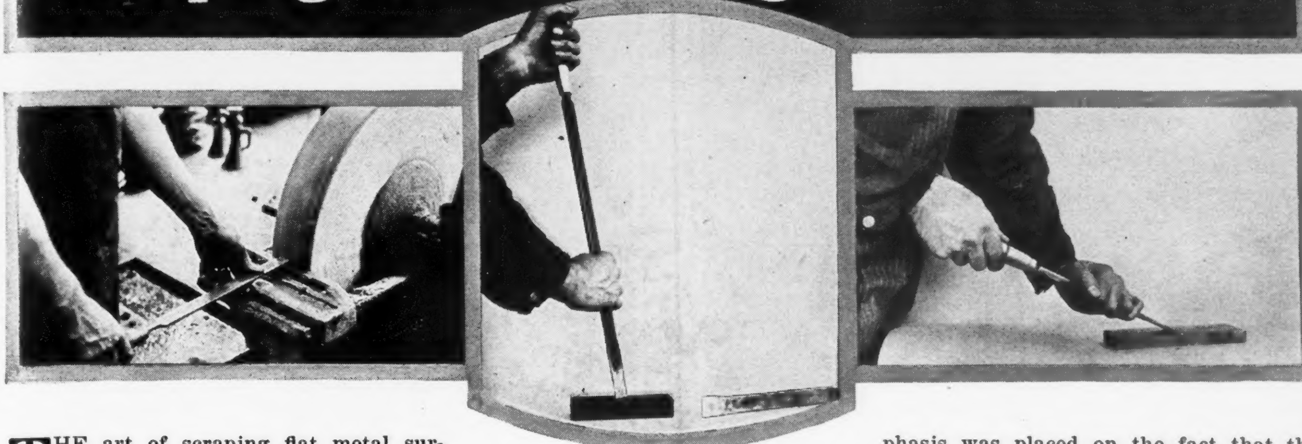
The chuck shown in the illustration is of the two-jaw type, and is used to hold work of the kind shown at *A* while the central hole is being bored. A chuck of the same general construction but having three jaws may be more desirable for a different class of work. This chuck was designed with a view to eliminating, as far as possible, the trouble caused by chips getting behind the moving parts.

The flange *B*, which is screwed to the end of rod *H* and operates jaws *C*, is caused to turn with the body *D* by pin *E*. The pin *E* is held in position by screw *F*. The flange *B* is beveled on its front face, so that any chips which may fall into the chuck behind the work are thrown forward and out through the opening at the side of the chuck body by centrifugal force. The rod *H*, which serves to actuate the chuck jaws, may be made to operate pneumatically or by a handwheel or a forked lever. The jaws *C* are a sliding fit in slots cut in the chuck body, and are held in place by screws *G*.



Two-jaw Chuck for holding Round Work while the Central Hole is being bored

Scraping and Frosting Flat Surfaces



By O. S. MARSHALL

THE art of scraping flat metal surfaces came up for discussion recently among some shop students who were under the writer's direction. As first there appeared to be a difference of opinion regarding the correct methods of sharpening and using a scraper. A carefully outlined course of instruction and experimental work in the shop, supplemented by reference to photographs showing a skilled workman in the exact positions assumed under actual working conditions, served to clear up all disputed points and fix the fundamental principles of scraping firmly in the minds of the students. The photographs and the information gathered and prepared by the writer for this course of instruction form the basis of the present article. The methods described and illustrated in the following are regularly employed in the plant of a well-known machine tool building company.

Fundamental Principles Involved

At the outset the difference between "cutting" and "scraping" was thoroughly discussed and demonstrated. Emphasis was placed on the fact that the desired surface obtained by scraping was achieved by reducing the high spots or "mountains" on the machined surface to a general level with the low places. It was also pointed out that the smaller crevices in the metal receive the very small chips or metal scrapings in the form of a powdered paste, which serves as filling, thereby helping to produce a surface that is more or less glassy or mirror-like in appearance. The same glassy surface, carried to an even greater degree of refinement, is produced by performing a polishing operation on the work.

Shape of Scraper

The shape or form of the end of the scraper, as well as the working angle of the scraper in the workman's hands, must be correct in order to obtain satisfactory results. In Fig. 3 is shown an enlarged outline of the end of a correctly sharpened scraper, the enlargement being approximately twenty times. This outline is a reproduction of one obtained from a shadow photograph.

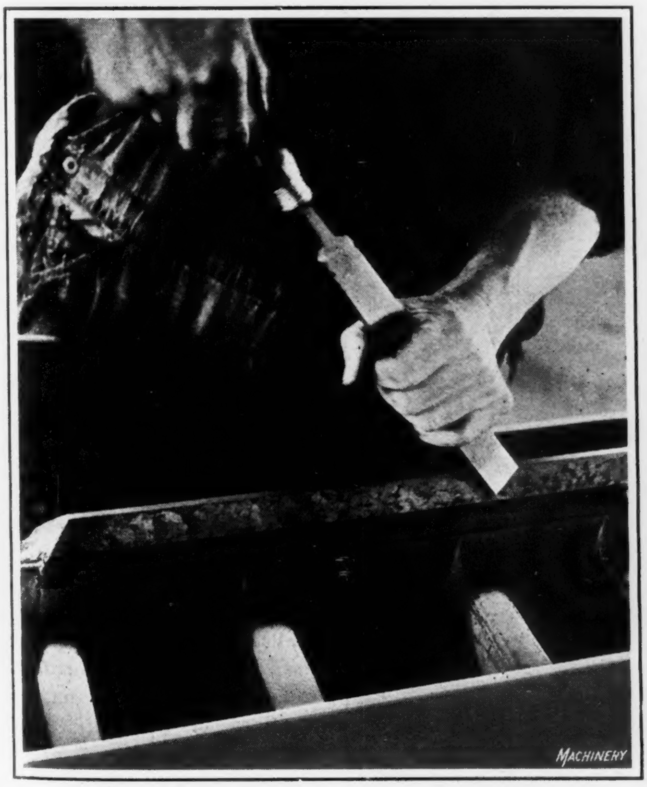


Fig. 1. Scraping the Ways of a Lathe

Fig. 2. Scraping the V-bearing of a Lathe Saddle

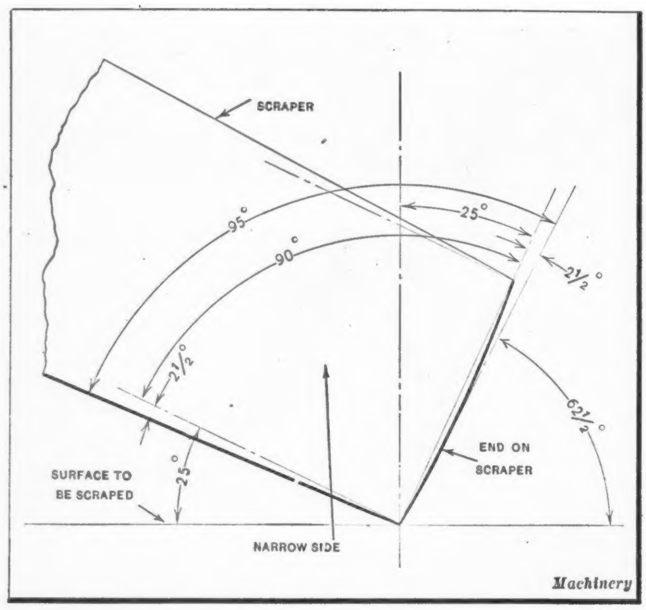


Fig. 3. Diagram showing Thin Edge of Correctly Sharpened Scraper (Twenty Times Actual Size)

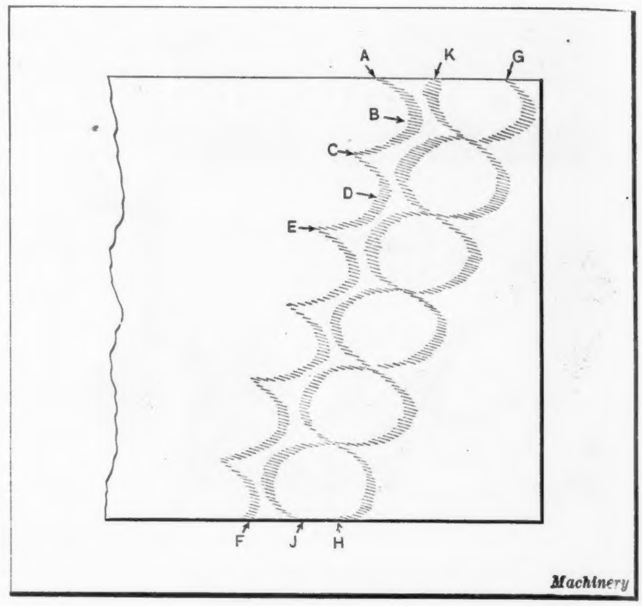


Fig. 4. Diagram illustrating Method of producing Crescent Frosting such as is used for Decorative Purposes

It will be noted that the end surface forms an obtuse angle with each of the flat sides of the scraper at the cutting edges. The crest of the end surface is approximately in the center of the thin end. The scraping edges formed by the sides and end surface have an included angle of 95 degrees as indicated. The end of the scraper (looking at the flat side) is also slightly curved, as shown in the lower right-hand corner of the central view in the heading illustration.

A well-known text-book used by one of the students recommended the use of a flat scraper sharpened in an entirely different manner. The tool illustrated in this book had a concave end for the scraping edge, produced by contact with the cylindrical face of an emery wheel during the sharpening or grinding operation. According to the text-book referred to, the ground scraper was to be held in a vertical position relative to the hone for fine edging, in order to obtain a square cutting edge. The disadvantages of a square cutting edge, as thus produced, for use on work of the kind under consideration were readily demonstrated by comparing the results obtained by its use with those obtained by a scraper sharpened in the manner described in this article.

Fortunately it was easy to find some poorly scraped surfaces which showed scraper chatter marks, as well as some well finished surfaces that were free from these defects. Surfaces duplicating the good and the faulty examples were next produced in a series of trials. These tests proved conclusively that the best results could be obtained with a scraper having a rounded end, ground and honed to the shape indicated in Fig. 3 and in the heading illustration.

Method of Sharpening Scraper

The illustration at the extreme left of the heading illustration shows how the scraper is held when the end is being ground to a slight curve. A fine-grain grindstone, about 3 feet in diameter is used for this operation. After being sharpened on the grindstone, the scraper is honed on an India oilstone in the manner indicated in the central view of the heading illustration. The scraper is inclined at an angle of from 5 to 8 degrees with the vertical when it is being honed, in order to form the end to the shape indicated in Fig. 3 and in the lower right-hand corner of the central view of the heading illustration.

Before the scraper is used, it may be given a stroke or two with the oilstone on its flat side, in order to obtain a keen edge. The several angles concerned in sharpening and in using the scraper are shown diagrammatically in Fig. 3. It will be noted that the 2½-degree angle plus the 25-degree angle of inclination gives the end of the scraper a reverse rake angle of about 27½ degrees.

Producing a Flat Surface

The position of the operator's hands in holding the scraper, and the angular position of the scraper in relation to the work when a flat surface is being scraped, are clearly shown in Figs. 1 and 2, and also in the view at the extreme right in the heading illustration. The "leaded" or high places (the dark spots) which are to be scraped down are shown quite clearly in Figs. 1 and 2. Fig. 6 is a close-up view showing the scraper marks, the work being ready to receive the testing jig or master plate, which, when rubbed on its surface, will show the extent of the contact surface between the plate and the work. After the master plate is removed, the high places, as indicated by the dark leaded spots, are all scraped down. By repeating this process of applying the master plate and then scraping down the high spots, it is possible to obtain a true flat surface. In scraping down the high spots on a flat surface, the scraper is made to remove metal only on the forward or pushing stroke. Before being scraped, a machined surface generally has a porous appearance, as shown in Fig. 5.

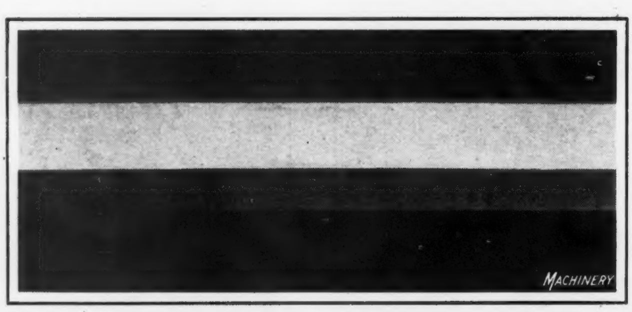


Fig. 5. Unscraped Machined Surface

Fig. 6. Surface shown in Fig. 5 after being scraped

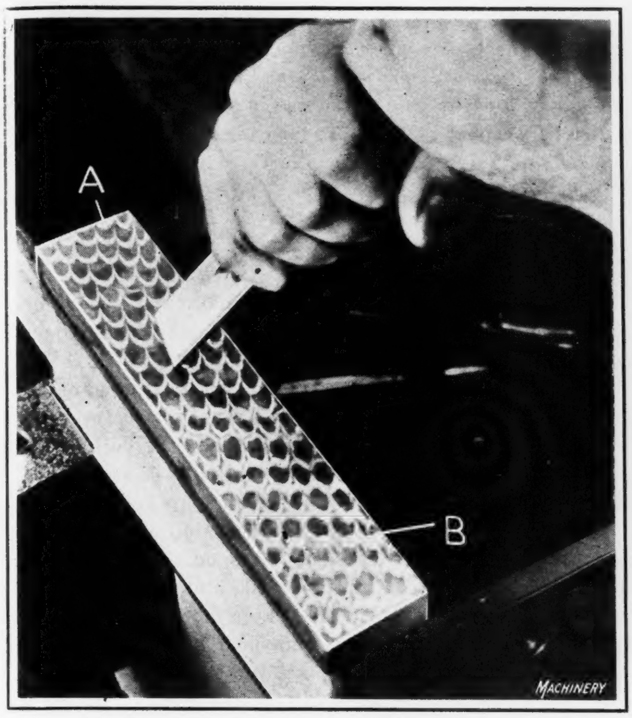


Fig. 7. Example of Crescent Frosting, showing Position of Scraper at Beginning of Crescent-forming Stroke

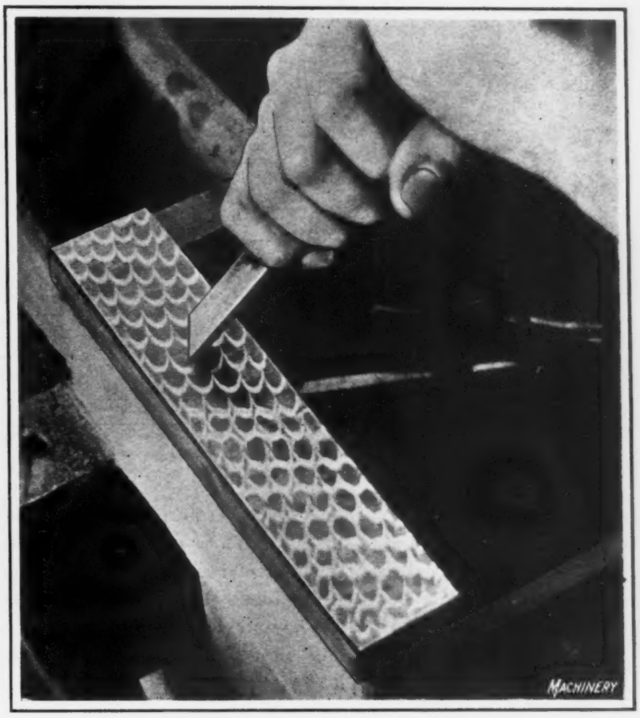


Fig. 8. View showing the Scraper in the Mid-stroke Position of the Crescent-forming Movement

Figs. 4, 7, and 8 will convey to the reader, if studied in connection with the text, a working knowledge of the method employed to produce the crescent form of frosting used by some machine tool builders. The frosting is done primarily for decorative purposes after the other work is finished. First the position of the workman relative to the surface to be frosted (see Figs. 7 and 8) should be carefully noted. The workman begins the frosting operation at the left-hand end or side of the surface to be frosted and works toward his right. Each stroke of the scraper is started at the edge opposite the workman. By drawing the scraper toward him with a peculiar oscillating movement, the workman forms a series of crescents which are tied together at their points. For decorative effect this series of crescents is usually laid diagonally across the surface, as shown in Fig. 7. If the full circle effect is to be obtained, as at *B*, the workman first frosts the work as shown at *A*, working from left to right (standing on the opposite side from that shown). After this has been done, he completes the second series.

In making the second series of crescents which give the complete circle effect as shown at *B*, the workman stands on the right-hand side of the work, as shown in the illustration. This illustration merely shows the position of the operator's hands and wrists at the beginning of the crescent-forming movement. The position of the scraper at the beginning and end of the crescent-forming movement is the same. It will be noted that the broad side of the scraper is nearly in full view in Fig. 7, whereas little more than the edge of the scraper is shown in Fig. 8. In the latter illustration, the mid-stroke position of the wrists and scraper are shown, the upper half of a crescent having already been formed.

The workman oscillates the scraper—he does not slide it—by a series of rapid and slight wrist twists, first from left to right, then from right to left, imparting a side rocking motion to the tool back and forth and continuously working it toward himself as each crescent is formed, until a string of crescents is formed completely across the surface. The workman then begins another series of crescents by placing the scraper at the edge opposite him, as previously described, and again rapidly oscillates or "waltzes" the scraper across the surface. This operation is repeated until the surface has been completely covered.

Briefly, the left-to-right movement, or half oscillation, forms the upper half of the crescent, as for instance, from *A* to *B*, Fig. 4, and the right-to-left or reverse motion forms the lower half of the crescent from *B* to *C*. These movements are repeated in forming the crescent *CDE* and each successive crescent, until a complete string extending from *A* to *F* is finished. After completing the crescents from *A* to *F*, the next string extending from *G* to *H* is produced in a similar manner. The addition of the series of crescents formed by strings such as the one extending from *J* to *K* gives the complete circle effect. The second series of crescents is produced in exactly the same manner as the first, the workman standing on the opposite side of the work, as previously explained. Sometimes when an especially clear frosting is desired, the surface is slightly polished with fine emery cloth. Needless to say, a little practice is required before it is possible to become expert in the art of frosting.

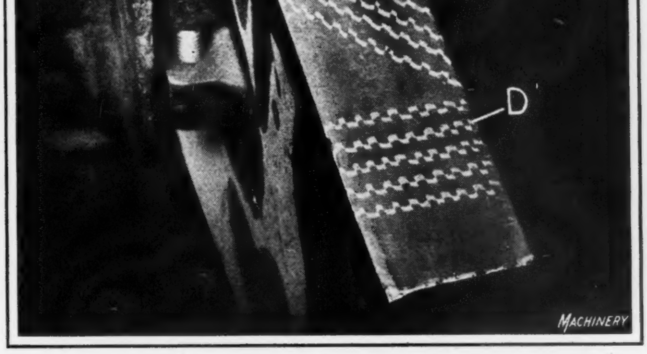


Fig. 9. Example of Diamond Style of Frosting often applied to Scraped Surfaces

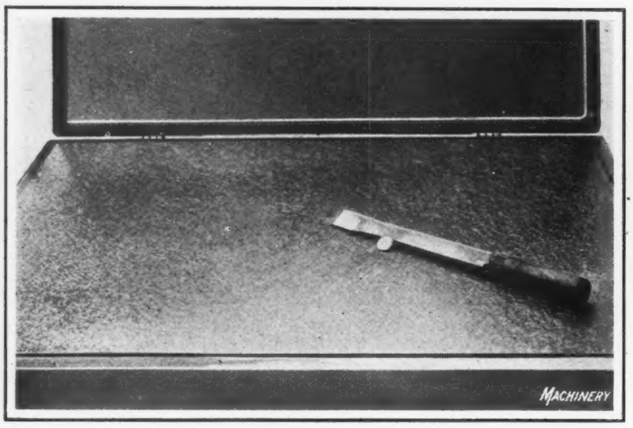


Fig. 10. Master Surface Plate used to test Accuracy of Surface Plates used in the Shop

In Fig. 9 is shown another type of frosting which, when fully worked in as shown at *A*, gives a genuine frost-like appearance to the surface. A surface frosted in this manner will scintillate light in all directions when observed under good lighting conditions. At *B* will be seen the scraper, which is preferably made long enough to enable the workman to support the handle end by pressing firmly against his shoulder. This illustration also gives a good idea of the correct amount of inclination to give the scraper. The strokes are all begun at the farther side of the work, the scraper being drawn toward the workman instead of being pushed from him, as in the case of scraping.

The end of the scraper that does the frosting is ground and honed to practically the same form as for scraping. In producing this style of frosting, which is sometimes called "diamond" frosting, either the diagonal series of spots, as shown at *C* or the straight-across series, as shown at *D*, may be made first. When both series have been laid on, the surface will appear as at *A*. The procedure in forming the series of spots is to bring the scraper a slight distance toward the workman, giving it sufficient pressure to mark but not to scrape the surface, and then slip it lightly to the right; next bring it forward again slightly and then slip it to the left, and again bring it forward. These movements are repeated until the complete surface has been treated. As the workman develops skill the "forward right, forward left" movements can be repeated rapidly, so that a surface of considerable size, such as the master plate shown in Fig. 10, may be quickly frosted.

The scraper is moved forward the same amount each time before it is moved sidewise. The length of the forward movement may be 1/8 inch or more, depending on the size of the surface to be frosted and the appearance desired. That the plate shown in Fig. 10 represents a really fine piece of scraping and finishing by frosting may be seen by noting the reflection of the cover at each of the corners where it is hinged to the protecting box. A scraper of ordinary size and a quarter dollar are laid on the plate in order to give some idea of the size of the plate. A master surface plate of this type is valued at several hundred dollars and is employed only in testing the surface plates used by the workmen in the shop.

* * *

SINGLE-RIB PATTERN THAT FACILITATES PRODUCTION

By M. E. DUGGAN

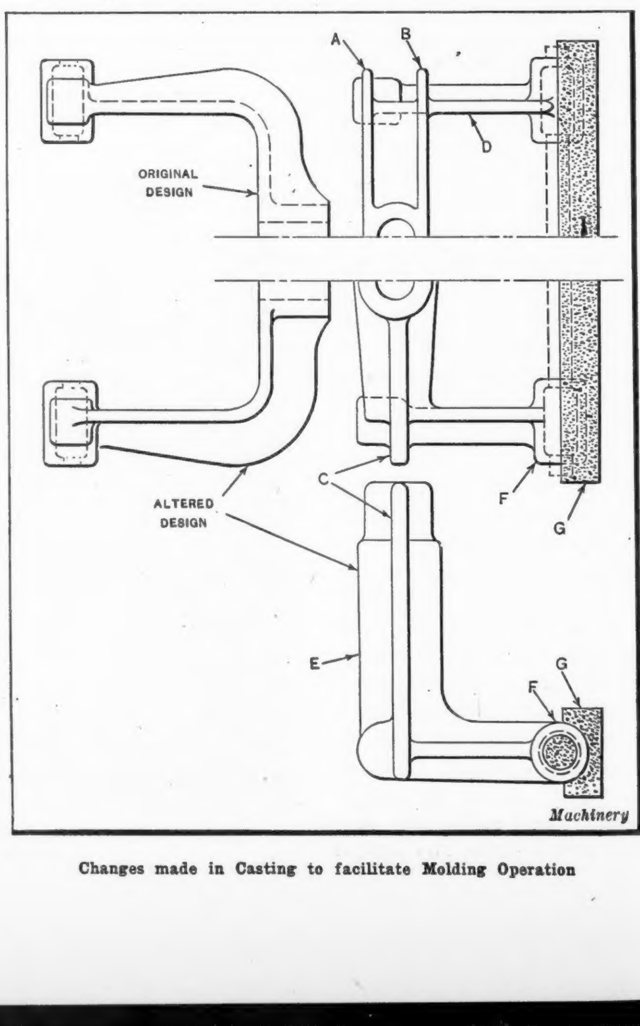
The two upper views in the accompanying illustration show the design of a machine casting which was required to be replaced on short notice. It will be noted that only a half-section of the casting is shown in these views. In order to facilitate making the patterns and molding, the ribs *A* and *B* were eliminated in making the repair part. A single rib *C*, as shown in the lower views of the redesigned casting, was substituted for ribs *A* and *B*. The single-rib casting gave the necessary strength and served every purpose required of the two ribs in the original design. The pattern for the original double-ribbed casting was made with a core-print between the ribs. This pattern was intended to be molded in the position shown in the view at the upper left-hand corner of the illustration. The whole pattern, in this case, was to be molded in the drag flask with the right-angle arms *D* down.

In the case of the redesigned pattern, the right and left cores required in molding the original two-ribbed pattern were eliminated. The section *E* was made loose where it joined rib *C* so that it could be lifted away with the cope. The two journal bearings were made loose at the point where they joined the right-angle arms. The core-print was, of course, made the same size and shape as the core *G*. This core-print was attached to the loose pieces *F* and extended completely across from one bearing to the other.

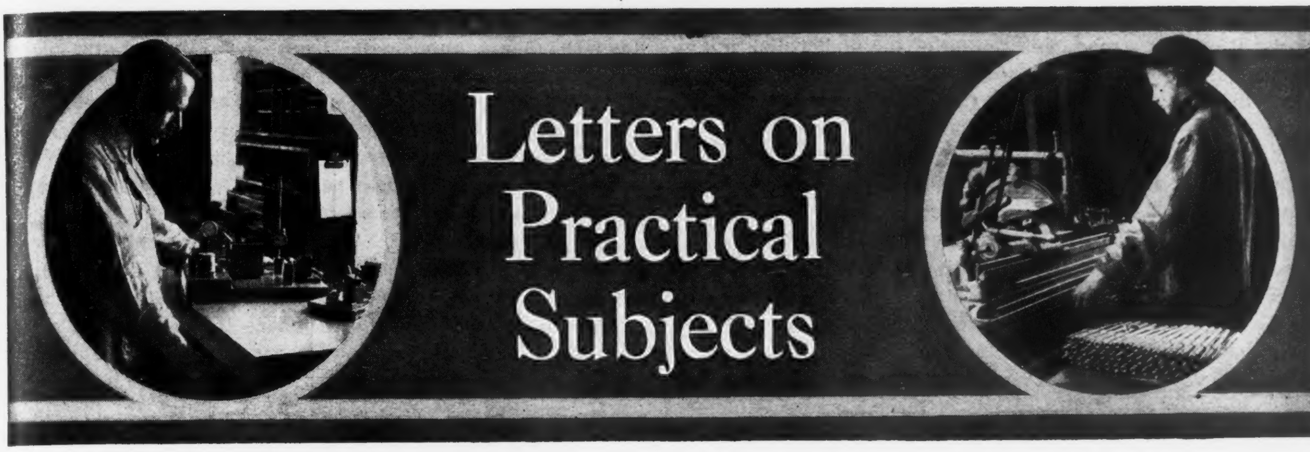
In molding the pattern, the loose section *E* was removed, and the bottom of the flat rib *C* laid on the bottom board. Sand was then shoveled into the flask, and the mold made up in the usual manner until the center of the bearing *F* was reached. The loose bearings were next lifted from the flask and the journal cores set in place in the mold. The ram-up cores *G*, which were made to match the hubs of the journal cores, were then put in place in the mold, after which the filling in of the sand was continued up to the top of the drag flask.

The drag was next rolled over and the loose section of the pattern *E* placed in position on the drag. The cope flask was placed on the drag, and sand filled in, thus completing the cope part of the mold in the usual manner. The cope was then lifted and the loose section *E* removed. The section of the pattern in the drag was also lifted, after which the cope was put back in place on the drag and the mold clamped together ready to be poured.

Patterns for repair parts are usually required on short notice, and for this reason the patternmaker who has this class of work to do should be quick to note any change in design that will enable the work to be done more quickly.



Changes made in Casting to facilitate Molding Operation



TACHOMETER FOR INDICATING HIGH SPEEDS

The measurement of high rotational speeds in the shop is receiving more attention at the present time than it has in the past. This is due no doubt to the increase in the use of high-speed abrasive wheels for finishing operations. Difficulty is often experienced, however, in obtaining correct indications at high speeds. An unusual method of solving this problem is described in the following: The method was developed and used at the plant of the Pratt & Whitney Co., Hartford, Conn. A simple device known as a flicker tachometer is employed. The particular device described was designed for general shop use where rotational speeds of from 300 to 500,000 revolutions per minute were to be indicated or measured.

A laboratory set-up of the flicker tachometer is shown diagrammatically in the accompanying illustration. This particular set-up is intended for indicating the rotational speed of the jack-shaft *B*, which has a speed of approximately 16,000 revolutions per minute. The device consists of a variable-speed electric motor *A*, a revolution counter *C*, a notched or serrated black disk *D*, and a rheostat *R* for varying the speed of the motor. Additional equipment consists of a target *T* attached to the shaft to be indicated, and a stop-watch. The motor is a simple direct-current type, is series-wound, and is capable of making 10,000 revolutions per minute when connected directly across the 110-volt alternating-current circuit. The power employed is about 10 watts.

The rheostat is used as a voltage divider. It has a resistance of 500 ohms and will carry a current of 1/2 ampere. The two end terminals are connected across the 110-volt line so that the current flows through the resistance wire continuously. The motor is connected across one end terminal and the slider, as indicated in the diagram. By moving the slider, any voltage from 0 to 110 volts can be impressed on the motor, and a wide range of speed thus obtained. On the motor shaft is mounted the flicker disk *D* which is made of heavy black paper. The periphery of this disk is cut or notched with five equidistant slots, each slot being about one-tenth the width of the adjacent uncut portions.

The purpose of this disk is to reduce the apparent rotation of the shaft under observation to zero when the end of the shaft is viewed through the rapidly revolving slots on the edge of the flicker disk *D*. When this is accomplished by varying the motor speed, the number of revolutions per minute of the motor is obtained by means of the revolution counter *C* and a stop-watch. The speed of the motor thus obtained is multiplied by the number of slots in the flicker

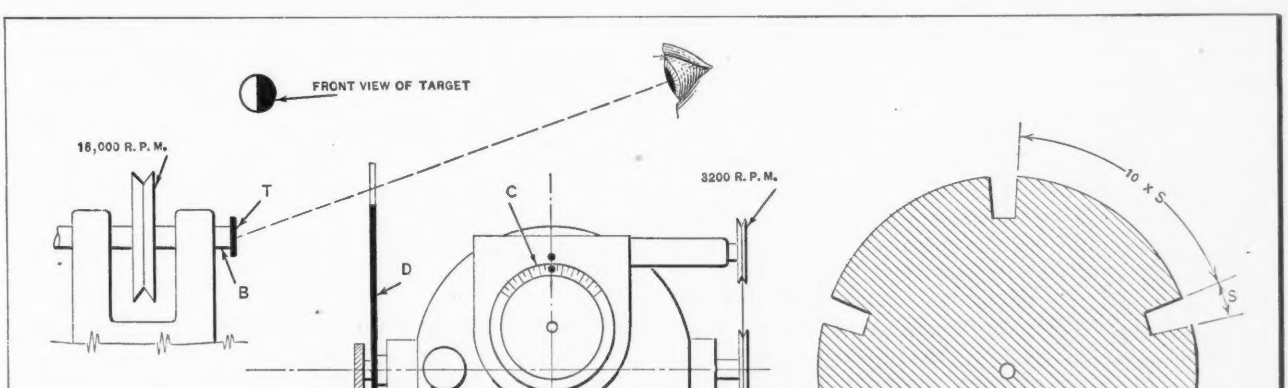


Diagram illustrating Use of Flicker Tachometer in determining Speed of a Shaft

disk to obtain the speed of the shaft under observation. In explanation, the stroboscopic action of the flicker disk might be compared to that of a moving picture camera, since it takes instantaneous pictures of the end of the shaft. If the shaft makes one revolution in the interval that successive slots in the flicker disk pass the eye, the shaft will appear to be always in the same position, and it will apparently stand still. When this condition obtains, the flicker disk may be said to have reached its synchronous speed. If the speed of the shaft being tested falls below this synchronous speed, the shaft will appear to rotate backward, and if its speed is increased so that it revolves faster than the synchronous speed it will appear to be turning forward.

If the shaft is running at one-half or twice the synchronous speed, it again apparently stands still, and errors in determining the speed may thus occur. In order to eliminate the chance of making errors of this kind, a target *T* with one-half its surface blackened as indicated in the illustration, is used as an observation point. A simple circular piece of paper that has half its surface black and the other half white, attached to the end of the shaft with gum or shellac so that it will revolve with the shaft, makes a suitable target.

At twice the synchronous speed, or in other words, when the flicker disk is not running fast enough, the target does not show a full 180-degree black sector, as it does when the synchronous speed has been reached by the flicker disk, but instead it appears to have a sector of about 120 degrees of dense black with grayed sections at each side, as indicated diagrammatically in the view at *E*. At one-half the synchronous speed when the flicker disk is revolving too fast, the target becomes gray with a single dark line through the center as indicated at *G*.

In the first case, the shaft has an opportunity of making one revolution while completely hidden behind the opaque portions of the flicker disk *D;* that is, the shaft is seen only in the position it occupies at every other revolution. Thus the period of time that the target is visible through any one slot is twice as long as when the flicker disk is running at the synchronous speed. This accounts for the attenuation of the dark area and the graying of its edges.

At one half the synchronous speed, when the flicker disk is running too fast, the shaft makes only one-half a revolution between the passages of the slots, so that the dark part of the target is seen first on one side of the center and then on the other side. Under this condition the target would appear to be of a uniform gray, if the slot or aperture in the periphery of the flicker disk were of negligible width, but since it has an appreciable width, the two positions overlap somewhat, giving the strong dark line through the center of the gray patch.

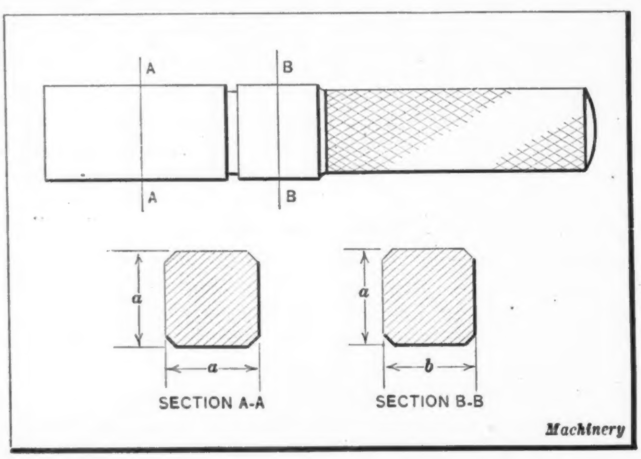
At other speeds, where the ratio can be expressed by a small fraction, crosses and spoked patterns appear. The appearance of the target when the flicker disk is running at the synchronous speed is shown by the view at *F*, while at *H* the target is shown as it appears when the jack-shaft has reached a speed of only one-third the correct synchronous speed.

This method of determining the speed of a shaft cannot be used satisfactorily in a room illuminated by arc lamps operating on alternating current, or where incandescent lamps are used that operate on a 25-cycle current, because the flicker of the lighting system is superimposed on the target, thus giving results that are difficult to interpret. When correctly employed the method of speed determination described has a number of advantages. In the first place, it can be used for a wide range of speeds, from 300 to 500,000 revolutions per minute. Second, it does not absorb power from the observed shaft. This is a particularly desirable feature in indicating the speed of spindles driven at extremely high speeds. Third, it can be used to obtain the speeds of shafts in inaccessible places by using set-screws, patches of grease, etc., as targets. The arms of pulleys, however, should not be used as observation points. Fourth, it will show rapid variations in the average speed which the ordinary tachometer will not show because of its more sluggish action.

Hartford, Conn. PAUL M. MUELLER

SQUARE-HOLE LIMIT GAGE

An improved type of square-hole limit gage has recently come to the writer's attention. The "Go" portion indicated by section *A–A* in the accompanying illustration is ground in the usual way, while the "Not Go" portion indicated by section *B–B* is ground on two opposite sides to the same dimensions as the "Go" portion. The remaining two sides are ground to the "Not Go" or high limit. Referring to the illustration, dimension *a* represents the "Go" limit and *b* represents the "Not Go" limit.



Limit Gage for testing Accuracy of Square Holes

The writer has used square-hole gages provided by some of the finest automotive and specialty shops of the country. Among all those used, only one shop employed the type of gage here shown. In view of the fact that a strong demand exists for accuracy in the dimensions across flats, this type of gage should become very popular.

In testing or gaging a hole, the "Not Go" portion of the gage should not, of course, enter the hole if the hole is machined to the correct size, but, regardless of whether it does or not, the gage should be removed and given one-quarter turn, and again inserted in the hole. In this way, the distance across either of the opposite flatted sides is gaged independently of the other two sides. As very few holes are machined absolutely square, the advantage of testing the accuracy of the hole with a gage of this type is obvious.

New London, Conn. GEORGE E. HODGES

TESTING FUEL OIL BEFORE ACCEPTANCE

Specifications for ordering fuel oil at a certain plant had been carefully drawn up to prevent the possibility of receiving a Mexican or high-sulphur oil for which the burner system of the plant was not designed. Through an error in shipping instructions, however, a car of Mexican oil was shipped to this plant and, as was customary, the oil was tested by a member of the works laboratory before being put into the storage tanks. The error was discovered, of course, and another car of the proper kind of oil ordered to take the place of the Mexican oil. A great deal of trouble was thus avoided, for had this heavy oil gotten into the system (which held about 30,000 gallons), it would have clogged up the needle valve burners, and the whole plant would have been tied up. It is the policy in this plant to have all raw materials tested by a member of the works laboratory before accepted for use.

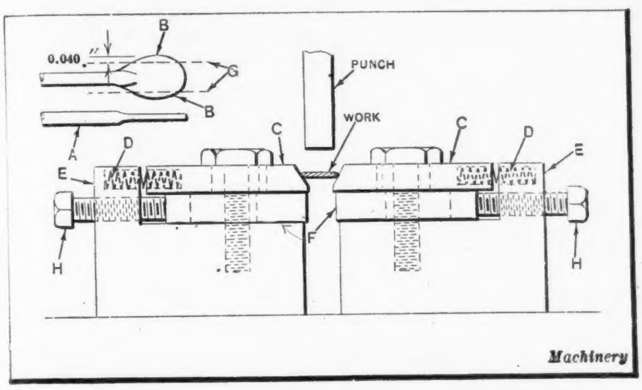
Philadelphia, Pa. ARTHUR L. COLLINS

TRIMMING DIE WITH UNIQUE LOCATING DEVICE

The die here illustrated is used to trim the sides *B* from parts such as shown at *A*. The flattened end of the work is placed in the vee formed by the guide plates *C*. As the punch descends, it forces the work downward, thus causing plates *C* to be pushed back against the tension of springs *D* until further movement is stopped by the upward projecting ends of blocks *E*. When this position is reached, the work has been pushed down until it rests on the upper faces of the trimming dies *F*.

The inner ends of slides *C* are in contact with the work at this time, and serve to centralize it over the trimming dies *F* so that the same amount of metal will be removed from each side. The continued downward movement of the punch forces the work past the trimming dies, thus trimming the flattened part of the work along the lines indicated at *G*. As the ends of the die-plates *F* overhang the die-blocks *E*, the work is left free to be removed when the punch has carried it past the ends of the die-plates.

The metal removed from the sides of the work remains on the die-plates *F* until the punch ascends. When the punch clears the die on the upward stroke, the springs *D* cause plates *C* to move forward and push the chips or trim-



Trimming Die for Part shown in Detail View

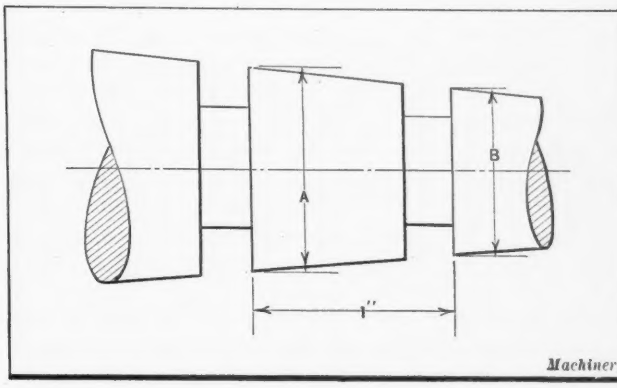
mings into the opening, so that they fall through a hole in the die-bolster. The ends of dies *F* are not given any clearance, and so the work is burnished in passing through the die. The ends of the dies, as well as the end of the punch, can be easily sharpened by grinding. The screws *H* provide a means of adjusting the die-plates *B* to a good cutting fit on the punch.

Philadelphia, Pa. R. H. Kasper

METHOD OF SETTING LATHE TAPER ATTACHMENT

A method of setting the taper attachment of a lathe which has been found satisfactory by the writer is described in the following: A piece of round scrap stock is first placed in the chuck or collet and the compound rest is then set at an angle of 90 degrees or parallel with the axis of the lathe spindle. A cutting-off or parting tool is next placed in the toolpost and the dial on the compound rest set at zero. Then, using the cross-feed, a groove or neck is cut in the stock to a depth of 1/4 inch, and the tool withdrawn. The feed-screw of the compound rest is then turned until the dial indicates a movement of 1 inch to the left, after which the tool is again fed into the work and withdrawn. This produces two grooves or necks having faces exactly 1 inch apart as will be seen by reference to the accompanying illustration.

The taper attachment is next set approximately to the taper desired and a trial cut taken across the work, which will leave two high points that can be easily measured with a micrometer. The taper attachment is then adjusted until



Method of turning Piece of Scrap Stock to facilitate testing Accuracy of Taper Attachment Setting

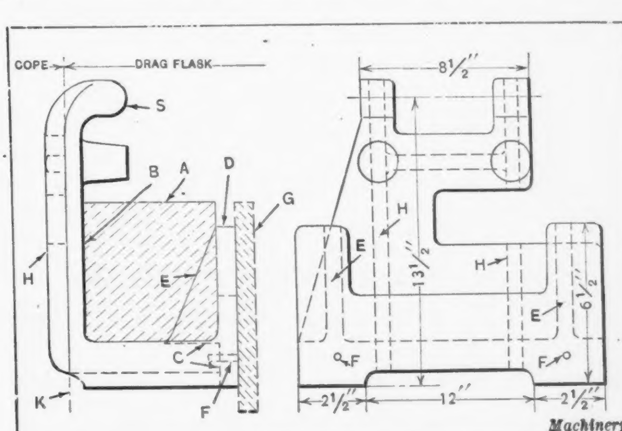
the difference between the diameters at the high points of dimensions *A* and *B* is equal to the taper per inch, or one-twelfth the taper per foot.

Erie, Pa. Leo R. Lynch

PATTERN FOR CAST-IRON BRACKET

Many draftsmen unnecessarily complicate the work of the patternmaker and molder by their attempts to reduce to as few as possible, the number of castings required for repair jobs or for constructing special machines or tools. When too many details or elements are combined in one casting, the resulting designs often present such difficult problems in patternmaking and molding that any advantage gained by a reduction in the number of castings is more than overbalanced by the difficulties encountered in making the patterns and in molding. However, the patternmaker can, and often does, simplify designs originated by the draftsman that involve needlessly complicated patternmaking and molding problems. In case the patternmaker fails to provide patterns that can be conveniently employed by the molder, the latter may make further changes in order to facilitate his work. For instance, in the production of the pattern shown in the accompanying illustration, changes in the original design which were suggested by the molder saved considerable time and resulted in a better casting.

The pattern was made for use in molding a bracket casting to replace one that had been broken. The original bracket was made in two pieces, which were machined and bolted together. Instead of making separate patterns for the two pieces as was originally done, the patternmaker made a pattern designed to produce a complete bracket in one piece. The one-piece pattern was made to be molded in a two-part flask. The space between the hinge bracket *S* and the foot was intended to be molded in a dry sand core, such as is shown by the dotted section at *A*. The hinge



Two-part Pattern for a Cast-iron Bracket

section of the pattern was intended to be molded in green sand. The reason given by the patternmaker for making the pattern in this way was that a stronger pattern would be obtained. A casting can be produced by the use of a pattern made in this way, but it is difficult to produce a dry sand core of correct size that will present a flat surface along the face of the casting at *B* when set in the mold.

The changes in the pattern suggested by the molder were as follows: The pattern was made in two pieces to be parted on the dotted line *C;* the foot *D* and ribs *E* were made loose, and held in place with dowel-pins *F*. The whole pattern was to be molded in green sand in the drag flask with the parting on the line *K*. As the cover core *G* entered into the molding operation, it was possible to use a two-part flask, but this core has nothing to do with the making of the pattern.

To one who is not experienced in molding practice, the making of a mold by the use of this pattern appears to be a complicated job. Actually the method is simple and one that can be used in making patterns for a great variety of parts. The whole pattern up to the line *K* was molded in the drag flask, and the ribs *H* were molded in the cope. According to the generally accepted rules for good patternmaking practice, all parts above the parting face should be made loose whenever possible. As there was but one casting to be made in this case, this rule was disregarded, and the rib pieces were nailed fast to the pattern. The ribs were given extra taper to facilitate lifting the cope.

The drag flask was placed on a bed of molding sand, and the pattern placed within the drag on the bed of sand with the ribs *H* imbedded in the sand up to the parting line *K*. Sand was shoveled in and rammed up to the top of the pattern. Next the loose piece *D*, with the ribs *E* fastened to it, was lifted out of the mold, being parted from the main pattern on the dotted line *C*. This section of the mold was then mended and finished in the usual way. The cover core *G*, more commonly called a slab core by foundry workers, was next placed over the opening left in the mold by the removal of the loose piece *D*. After setting the cover core in place, the drag flask was completely filled in with molding sand. It was then rolled over and the cope flask put in place. The cope part of the mold was then completed in the usual way. After lifting the cope and removing the remaining section of the pattern, the cope and the drag were locked together, thus completing the mold.

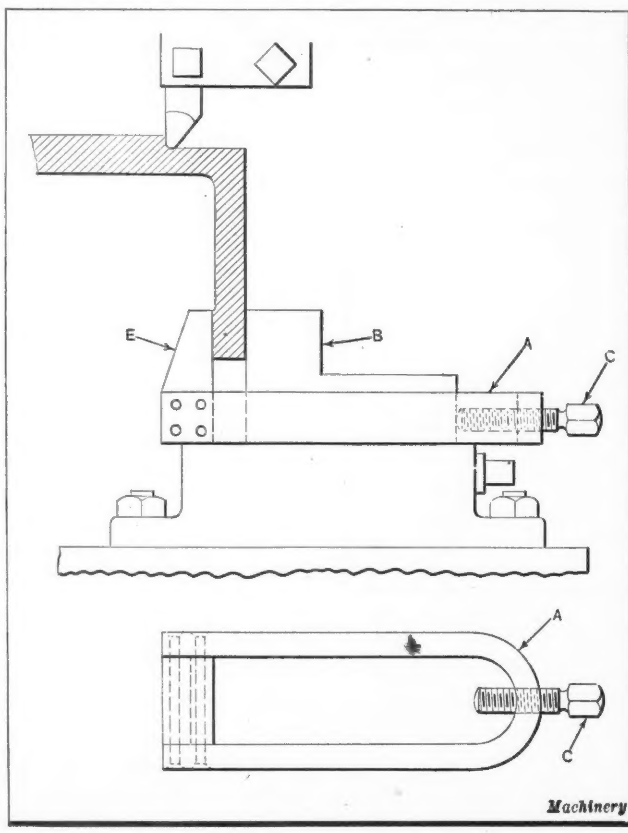
Kenosha, Wis. M. E. DUGGAN

A NON-SPLITTING WOOD SCREW

An improvement in the ordinary wood screw can be made by grinding a flat down one side of the threaded part of the screw, thus enabling the screw threads to tap out a hole for themselves. This expedient has been used successfully on pattern work. It eliminates the necessity for first drilling out the screw hole, in order to prevent splitting the wood, and does not appreciably weaken the joint. P. R. H.

SUPPLEMENTARY JAWS FOR BORING MILL CHUCK

Difficulty is often experienced in holding thin rings, cylinders, or drums in the regular chuck of a boring mill. If the jaws are adjusted to clamp the work tight enough to permit taking a heavy cut, the work is likely to be distorted or sprung out of round. On the other hand, if the jaws are clamped lightly on the work, there is danger of the work slipping. In order to overcome these difficulties and make it possible to take heavy cuts, supplementary jaws like the one shown at *A* in the accompanying illustration were designed for use in one shop. These jaws were slipped over or around the regular jaws *B* as shown. The regular jaws are first tightened, after which the supplementary jaws are brought against the inside of the work.



Supplementary Jaw for Boring Mill Chuck

The supplementary jaws are tightened by means of the screw *C* located at the rear of the clamping strap. The clamping straps, in this particular instance, were made of ½- by 1½-inch steel stock, and the jaws *E* were made up of steel to suit the width of the regular jaws. The straps were fastened to the jaws by means of rivets and by welding. By properly proportioning the length of the straps, work of any thickness can be held in place.

JOE V. ROMIG
Allentown, Pa.

* * *

The spontaneous breaking of main springs in watches has been investigated by S. R. Williams of Oberlin College. An examination of the records of several years of two firms doing a large repair business in watches indicated that there is a peak in this business in the summer, fairly coincident with the occurrence of the greatest number of thunderstorms. Further experiments indicated that the breakage is not due to heat, however, but to moisture. It is believed that the moisture acts by starting rusting points which weaken the spring. In an experiment in which fifty-six samples were tried, equally divided between two well-sealed jars, one containing dry and the other moist air, seventeen springs out of twenty-eight broke in the moist air, while none broke in the dry jar. Oiling the springs was found to markedly decrease the liability of breakage.

* * *

The primary safeguard to continued prosperity will be continued willingness of our people to save their enlarged earnings, to resist extravagance and waste, to give full individual exertion. Our second safeguard rests upon the individual business man in today's well developed sense of caution and resistance to the will-o'-wisp of higher prices and over-expansion and speculation. Our third line of defense is our credit men and our bankers who can check the dangers of speculative credits. The danger point arises when there is an over-ordering of goods. Our bankers in daily contact with the commercial fabric of the country are fully alive to their responsibilities.—*Herbert Hoover*

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, June 12

THE engineering industry continues to show periodic pulsations, each succeeding cycle leaving conditions generally a little better than before. The disappointing feature in the machine tool branch is that the rate of trade acceleration in the second quarter of the year has not kept pace with the first three months. Inquiries appear to be plentiful in all departments, but the period required for maturing into orders is very lengthy.

Conditions in the Machine Tool Industry

Machine tool firms having a fairly wide range of products are doing better than those that make but a single type. The wide variation in the experience of different concerns is shown by the fact that some report conditions to be considerably improved over six months ago, while others have found the depression at a lower level during the last few months than at any time for two years.

Makers of lathe and drill chucks, centers and sockets, state that business is very difficult to negotiate in the face of German competition. Conditions, however, show an improvement, compared with a few months ago, and France is stated to be a fairly good customer for some of these goods. The independent type of chuck is said to be in much better demand than the self-centering type, indicating a return to the manufacture of a variety of goods rather than a single specialized product.

Except in the heavier types, lathe makers are not very busy, but in plate and bar working machines substantial progress is being made. India is a good customer, and there is a fair amount of work on hand on account of British shipyards and steel works generally. Inquiry also is exceptionally good; in fact, one large firm that specializes in heavy hydraulic machinery finds it necessary to run night and day in the estimating and drawing office departments. Rolling stock makers and locomotive builders are becoming increasingly interested in machine tools, and there are excellent prospects of some good orders maturing from these sources in the near future. Meanwhile, financial considerations hamper the placing of business; that is to say, firms want new tools and could make good use of them, but for the moment they are prevented from buying by lack of capital.

Inquiries, however, in addition to being scattered broadcast throughout all machine tool manufacturing countries, mostly arise from reconstruction schemes, either in government or railway work-shops, and such orders usually take a long time to mature. The number of inquiries and orders received by machine tool makers for repair parts for second-hand machines bought at sales shows clearly how badly the trade has been hit by the accumulation and disposal of surplus equipment, and it will doubtless be some years before this effect is eliminated. Recent inquiries from Russia for saws and tools are causing manufacturers to hope for a repetition of the good business that was done last year in these lines and on a cash basis.

General Engineering Field

Textile machinery makers and those engaged in the manufacture of details for these trades are fairly well employed. The builders of electrical machinery also have little cause for complaint, and the brass trades are receiving a fair volume of inquiries which, it is hoped, will shortly turn into business.

Among railway engineers a brighter tone is noted. Locomotive builders have recently obtained a number of domestic and overseas orders, and it is understood that large additional orders will be placed in the near future on behalf of the Dominions and countries in the Near East. Rolling stock makers are also much more active, several orders for railway cars having recently been placed by the London & North Eastern Railway Co. Works engaged in the production of railway tires, wheels and axles, and buffers and springs are busy on domestic, Indian, and Canadian orders.

Iron and Steel Industries

Iron works in Lanarkshire are gradually opening up, and since the first of the year several thousand men have found employment. Scottish foundries are busier than they have been for several years. In Sheffield, the iron and steel industries appear to be marking time, the recent rapid price advances, ranging from 40 to 50 per cent, in the common brands of steel, having effectively applied the brake so far as the placing of new orders is concerned. In the heavy steel departments, which are booked well ahead, contracts generally were entered into before the recent series of advances. The output is now stated to be on a pre-war scale, while for basic and acid steel it is even greater, as the present greatly increased capacity is now working at about four-fifths of its maximum capacity. In some districts, more than twice the number of iron and steel furnaces are in operation, as compared with twelve months ago, and the rolling mills are in full swing.

With the general engineering trades recovering but slowly and the shipyards with room for many more orders, the demand for tool steel continues to be low. The trade in edge tools is very disappointing, although makers of saws are doing a little more business. With restricted Continental production and high American costs, it is considered possible to increase the trade with the colonies and South America, as stocks in the lighter steel trades are low and requirements great.

Overseas Trade in Machine Tools

The returns for April show a recovery in the volume and a fall in the average value of exports of machine tools. Thus during April the total exports reached 1183 tons, as against 911 tons in March, the corresponding values being £125,390 and £119,441. Imports continue to oscillate, as they have for the last two years. In April imports reached 300 tons with a value of £42,368. The value per ton of exports fell to £106 and that of imports rose to £141.

New Machine Tools

A new departure has been made in machine tool design by Wilkins & Mitchell, of Darlaston. Briefly, the machine may be said to consist of a number of standard drill heads, each carrying a set of adjustable drill spindles, which may be arranged in any order within the scope of adjustment to suit the work in hand. The heads are self-contained electrically driven units, and may themselves be mounted in any desired series on a frame which is built up of standard sections that may be added to indefinitely to accommodate the drill heads in any required horizontal, vertical, or angular positions. The machine can be arranged for simultaneously carrying on different operations; for example, milling may be done at one point while drilling or some other operation is in progress at another part of the machine.

MAKING LEATHER BELTS ENDLESS

By LOUIS W. ARNY

Almost any kind of belt can be made endless by the belting manufacturer, and when an endless belt can be placed around the pulleys without an expenditure of too much time and effort, and there is provision for taking up the stretch, new belts should be ordered to be made endless. If it is necessary to take down shafting and pulleys to install such a belt, or if there is no provision for taking up the stretch, a belt made endless at the factory is impracticable. Some belts can be made endless on the pulleys satisfactorily, and some cannot. This article applies only to leather belts or to those that can be made endless on the pulleys satisfactorily. Making a belt endless on the pulleys is like many another job in that it appears difficult and complicated, but when the trick has once been learned, it will be found to be remarkably simple.

Fig. 1. Starting to turn over the Edge of the Turned-edge Scraper

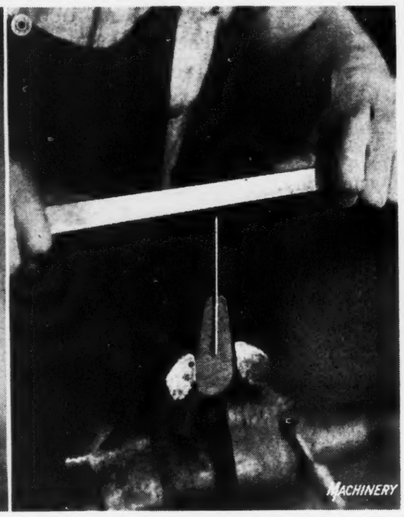


Fig. 2. Completing the turning over of the Edge of the Turned-edge Scraper

The tools required are as follows: (1) Clamps and rods; (2) belt scraper; (3) slicker; (4) belt hoe; (5) belt shave; (6) spoke-shave; (7) long skiver; (8) heel chop; (9) knife sharpener; (10) steel sharpener; (11) awl; (12) drive punch; (13) blind punch; (14) staple puller; (15) glue kettle; (16) ripping hammer; (17) screwdriver; (18) pegging hammer; (19) hand punch; (20) 3½-inch best glue brush; and (21) safety copper glue kettle.

Any of these tools not already on hand may be obtained from leather belting manufacturers. There is only one of them that is unusual to the ordinary mechanic—the turned-edge scraper (see Fig. 1). The blade of this tool is formed of a flat piece of good steel, about the thickness and quality of good saw steel. This blade is fitted in a handle, as shown. The unusual feature about this tool is that it has an edge that is turned at right angles to the blade. This is accomplished by first grinding a long edge and then rubbing this down to a fine edge on a "clearingstone." A smooth, hard, steel tool is next used, as shown in Fig. 1, for turning this edge so that it is at right angles to the blade. With the scraper firmly held in a vise, pressure is applied on one side, about at the angle shown. When the edge is smoothly and uniformly turned to this angle, the angle of the steel tool is changed to about half way between the positions shown in Figs. 1 and 2, and the process repeated. The steel tool is then held at right angles to the blade (see Fig. 2) in order to turn over the edge to the right-angle position.

There is a small steel tool known as a "steel sharpener" which is round, slightly tapered, and has a smooth, hard point; this is used to keep the turned edge of the scraper in good cutting condition, by rubbing the hard point on the under side of the turned edge, and the surface of the tool on the upper side. These turned edges are fairly durable, when working in leather, but when they are gone it is necessary to grind the tool again and repeat the process of forming the edge. The scraper is one of the most important tools in the belt-maker's kit, because it saves much time in cutting laps, and because by its use it is possible to scrape down a lap to an even bevel, and to make sharp points on the laps.

Making Laps

In making the laps on the belt, the first step is to decide on the length of the lap desired. Generally speaking, it is wise to make a new lap of the same length as the others in the belt, although in the case of double belts, this may be varied to suit the conditions. One lap should not be made over another one, and it may be necessary to make a lap longer or shorter to avoid this. The things to be remembered are that the line of the point and the line of the heel must be exactly square with the edge of the belt, that the bevel from heel to point must be uniform and regular, and that there must be no "humps," especially back of the point, to prevent the proper adhesion of the cement at every point of contact.

Next, clamp the belt to a table, so that both hands are

Fig. 3. Cutting away the Material for the Lap Joint with the Spoke-shave

Fig. 4. Scraping down the Joint to a Fine Point with the Turned-edge Scraper

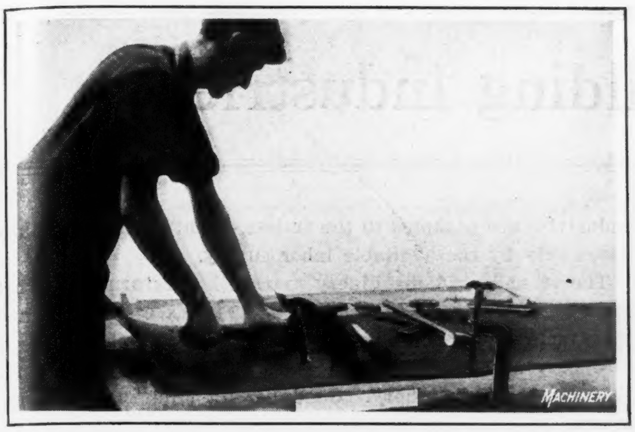


Fig. 5. Scraping off the Old Glue at the Joint

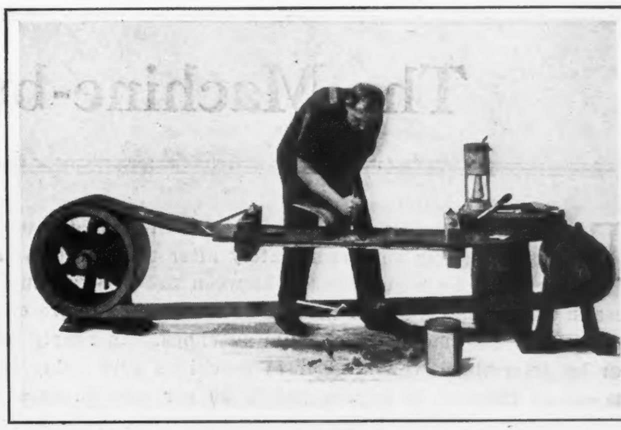


Fig. 6. Spreading the Cement and working it into the Fibers

free for the use of tools. Measure the lap desired, and mark across the belt a line, drawn by the use of the square, representing the end or heel of the lap; then proceed, with the spoke-shave, to cut away the material from this line down to the end of the belt, the latter becoming the point of the lap (see Fig. 3). The lap should be "roughed off" with the spoke-shave, and then scraped down to the point with the scraper (Fig. 4), and trimmed up with the knife. A small steel plane can also be used to advantage in connection with the spoke-shave.

Care should be taken to remove all the old glue, the scraper being used as shown in Fig. 5, in order to present a clean fresh surface to the cement. The glue should be hot, and not too heavy; it should be spread thin and worked carefully into the fibers of the leather, as shown in Fig. 6.

Next bring the two glued surfaces together, taking care that they do not slip on each other. Rub the joint with a scraper handle to supply a little pressure, or place the joint between two small boards and apply pressure with the bench clamps. Permit the glue to "set" for an hour before putting the belt on the pulley.

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ANNUAL MEETING OF SOCIETY FOR TESTING MATERIALS

The twenty-sixth annual meeting of the American Society for Testing Materials was held June 25 to 29 at the Chalfonte-Haddon Hall, Atlantic City, N. J. Among the many subjects dealt with at this meeting were the following: Non-ferrous metals and alloys; copper wire; methods of casting test specimens of gunmetal; influence of the ratio of length to diameter in compression testing of babbitt metals; corrosion of iron and steel; corrosion of non-ferrous metals and alloys; endurance properties of steel; resistance of manganese bronze, duralumin, and electron metal to alternating stresses; magnetic analysis; a new method of magnetic inspection; the significance of tool temperatures as a function of the cutting resistance of metals; and heat-treatment of iron and steel. Copies of the papers presented before the meeting may be obtained by addressing the society at its headquarters, 1315 Spruce St., Philadelphia, Pa.

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At a recent meeting of the Association of Gas and Internal Combustion Engine Builders and of Builders of Gas Producers in France, attention was called, says *Le Genie Civil*, to the use made in France of the abbreviation H. P. for horsepower, this expression designates the British and American unit of power, which is equal to 33,000 foot-pounds per minute, or approximately 76 kilogram-meters per second, whereas the French horsepower, and the horsepower as used in all countries employing the metric system, is only 75 kilogram-meters per second. It was suggested that in the future the metric horsepower be designated C. V., an abbreviation of *cheval-vapeur*.

TOLERANCES IN MACHINE BUILDING

It would be of great value to the shops engaged in building machinery of various kinds if more data were available on the subject of tolerances used by leading machine builders in their work. It does not seem possible to determine definitely the tolerances that should be used for different classes of fits under all conditions, and any attempt to lay down specific rules is likely to prove useless, but a great service could be rendered the industries by the Bureau of Standards or by the American Society of Mechanical Engineers if tolerances now actually employed in the building of a number of different machines and mechanisms were placed on record.

For example, suppose that through the Bureau of Standards a number of high-grade steam engine builders would agree to place on record the tolerances used in their shops on cylinder diameters, pistons, piston-rings, piston-rods, and bushings, crankshaft bearings, and other important parts where fits of different kinds are required. This would prove of considerable help and guidance to other manufacturers building similar types of machines, and would enable them to establish a system of tolerances and limits for their work. Gradually, such tolerances could be collected from every important field in the machine industries—machine tools, steam engines, steam turbines, pumps, gas engines, hydraulic turbines, automobiles, trucks, tractors, sewing machines, cranes and hoists, to mention only a few of the larger industrial divisions. A work of this kind is of such magnitude and importance that it can be successfully undertaken only by a public agency, such as the Bureau of Standards, or a professional society with a large membership, such as the American Society of Mechanical Engineers. There is no doubt as to the value of the work. Its cost should not be prohibitive, because it is a work that can be carried on gradually.

* * *

CHROMIZING

In a paper presented before the annual meeting of the American Electro-chemical Society, F. C. Kelley described in detail the process of chromizing and its effect on the physical and chemical properties of iron and steel. This process is somewhat similar to the well-known process of calorizing. It consists of packing the material to be treated in a powdered mixture of alumina and chromium—45 per cent of alumina and 55 per cent of chromium, by weight. The material is usually packed into a tube of iron, which is then heated to from 1300 to 1400 degrees C. in hydrogen, vacuum, or some neutral atmosphere. Chromizing has been used on turbine buckets in order to protect them against corrosion. As regards resistance to corrosion, chromized iron samples have been tested in comparison with sherardized samples and found to be equal to the latter. By casehardening and heat-treatment chromized iron may be made very hard.

The Machine-building Industries

THE great expansion that took place in the machine tool industry during and immediately after the war is well illustrated by a comparison between the pre-war business in this industry, the business done today, and the present capacity of the machine tool building shops. As nearly as can be determined, the number of machines sold today in the entire industry is approximately 50 per cent in excess of the average number of machines sold previous to the war; but notwithstanding this increase in demand, the machine tool industry, as a whole, is now occupied at only from 50 to 60 per cent of its capacity. Some shops, of course, have a greater volume of business than this, and in many instances the output is limited not by lack of orders, but by a scarcity of skilled labor. Several plants are operating to the fullest extent possible with the men available, and would increase operations if skilled help were to be had.

The demand is especially good for automatic machinery, some lines of drilling machines, and lathes. There is not quite so active a demand for planers, shapers, and milling machines. Some makers have found the difficulty of getting gray iron castings a limiting factor in their output. All gray iron foundries are occupied to capacity, with deliveries quite far in the future. The demand for forging machinery is good, and the shops in this field have all the business they can handle with the available labor supply. The demand for punching and shearing machinery is also good.

The Small Tool Industry

In the small tool field, the demand is fully normal; some of the drill manufacturers are unable to operate their plants to capacity because of lack of help. One manufacturer of drill chucks states that his present business is larger than ever before, and the special tool and equipment shops in the larger manufacturing centers in the middle western states are reporting unusually good business; only in the milling cutter field is there less than a normal demand.

One of the commercial agencies states that at the end of the high-pressure period in 1920 there were not less than 4700 tool shops making jigs, fixtures, gages, and special equipment in the United States—shops that had no regular line of manufacture and that employed anywhere from two to twenty-five men, only a very few being larger than this. Of these more than one-half are no longer in existence, owing to lack of business, but there are still about 2000 of these shops, and the better among them are now enjoying a good business.

Conditions in Special Fields

The demand for vises is good, and one concern states that April was the best month in volume of business in the history of the company. Good business is looked forward to in this field for the rest of the year. In the gear-cutting field, both the jobbing shops and those cutting automotive gears are fully occupied in most parts of the country. Some of the shops cutting automobile gears have orders for six months ahead and are working night shifts. The die-casting shops are active; most of them are taxed to capacity, and some are working over-time. The metal stamping and pressed steel shops have all the work they can handle; the gray iron foundries, as mentioned, are working to capacity and yet are unable to cope with the present demand on their facilities; and the forging shops are enjoying a normal business. In the ball and roller bearing field, the plants are running to capacity, and as a whole the machine-building industries are occupied to the fullest extent, limited in many cases only by the available labor supply.

The second-hand machinery market has returned to what must be considered a normal state. The excess second-hand machinery has been sold off, and dealers state that there is now only a regular supply to meet the normal demand for this class of machinery. Good second-hand machines are scarce.

Conditions in the Railroad Field

The railroads are in a better position financially than they have been for many years, and have placed unusually large orders for new rolling stock. There has also been a fair amount of buying of shop equipment, although proportionately less attention has been given to such equipment than to locomotives and cars. During the first four months of the year the railroads ordered over 1500 locomotives and 57,000 freight cars. Altogether there are about 2000 locomotives on order, still to be delivered, and over 100,000 freight cars. The railroads report record freight loadings during the past month. There are fewer freight cars in need of repairs than at any time in the last three years.

The Automobile Truck and Tractor Industries

Automobile production again broke all records in May with a total of over 400,000 cars and trucks, a rate of production equal to nearly 5,000,000 cars a year. The schedules for June are large, but after that a somewhat reduced output is generally expected. During the twelve months ended April 30, 3,208,000 new automobiles were sold in the United States. In spite of this great production, the demand is still said to be ahead of the output, and the manufacturers of the leading makes of cars complain about the shortage of labor and materials. The well-known automobile companies are in a stronger financial position than ever before, while some of the smaller ones have gone into receiverships.

The Iron and Steel Industry

The basic industry in the machine-building field—the iron and steel industry—is unusually active. The great demand of two months ago has fallen off somewhat, but this is favorable to continued prosperity in the machine-building field rather than otherwise; a lessening demand for raw materials will prevent further increases in prices. Deliveries are so far in the future that even with a decrease in new orders, production continues practically unchanged. The pig iron output during the month of May broke all previous records, as did also steel ingot production.

Summary of the Business Situation

In reviewing the business situation, the Federal Reserve Bank points out that the business pulse is steadier—not weaker—as a result of the discriminating attitude adopted in buying. A spirit of conservatism is evident, which is reassuring. This is an indication that the continuation of sound prosperity is preferred to a business boom. Most business men do not want industry to travel so fast that it will become travel-worn. At present there is little evidence of unwieldy inventories; and there is an indication of a desire to keep bills paid up. Generally speaking, business is now on a more substantial basis—more normal—than it has ever been since the beginning of the world war. There is neither abnormal demand, caused by artificial conditions, nor lack of demand, caused by business depression. "Normalcy" has at last arrived.

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

Fellows Thread Generator

FOR generating threads on taps, worms, hobs, and similar parts at high rates of cutting speeds, the Fellows Gear Shaper Co., Springfield, Vt., has recently placed on the market a machine that operates on the molding-generating principle, using a helical gear-shaper cutter. The principle of operation can best be understood by considering the threads as rack teeth wrapped around a cylinder in a helical path. The work rotates on an axis at right angles to that of the cutter, and the cutter rotates in harmony with the work; that is, the work and cutter are geared together in relation to the number of teeth in the cutter and the number of threads on the worm. The cutter is carried in a head mounted on a slide that is traversed longitudinally along the work, and as the cutter is rolled in mesh with the work, it produces threads by the molding-generating process. Some idea of the production possibilities of this new thread generating machine can be obtained by studying the action of the helical gear-shaper cutter that is employed. The following description will make clear the nature of the cutting action:

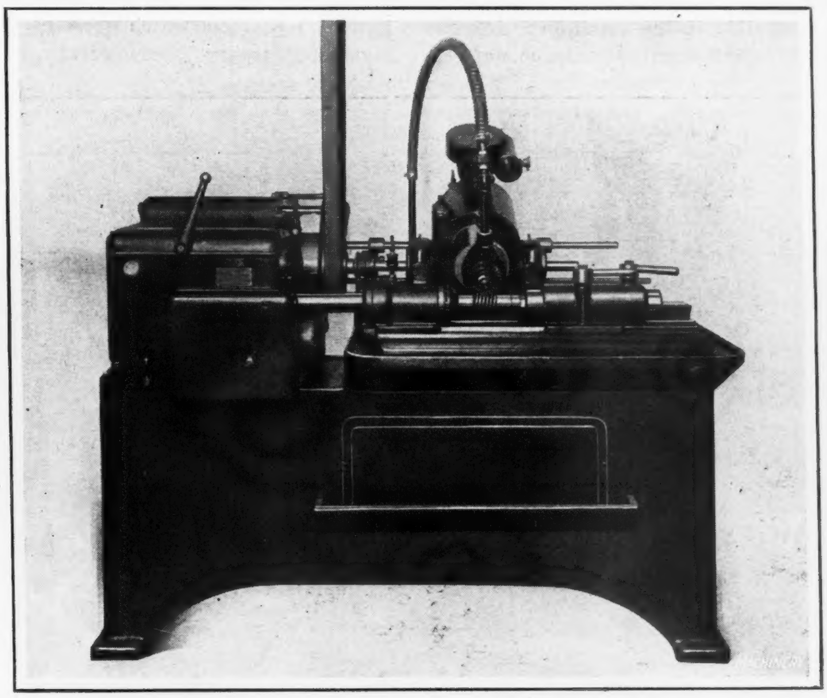


Fig. 1. Fellows Thread Generator for Worms, Hobs, Taps and Similar Work

The principle of generation, as applied on this particular machine, enables the cutter to be operated at a high rate of speed, which results in several advantages over other forms of thread-cutting tools. First, as the cutter is rolled in mesh with the work, any particular part of the cutting edge on the tool remains in contact with the work for only a very short period of time. Second, this rolling action enables the cutting tool to take a "shaving" cut, so that a comparatively coarse feed can be employed. Third, one tooth is not depended upon to do all the cutting, as there are many teeth which are brought successively and at a rapid rate into contact with the work. In this process, the cut is a combination turning and milling one, having the good features of both and the disadvantages of neither.

As an illustration of the work that may be performed, it will be assumed that a triple-threaded worm, 2.100 inches in outside diameter, is to be generated, and that the worm can be rotated at a speed of 600 revolutions per minute. If the cutter used has a pitch diameter of 3½ inches and a circular pitch of 0.525 inch, it would have 21 teeth and should rotate at a speed of 57.14 revolutions per minute. At a work speed of 600 revolutions per minute, the cutting speed at the periphery of the work would be 330 feet per minute. Each tooth of the cutter would remain in contact with the work for approximately 1/20 of a second, as 1200 teeth would be presented to the work every minute. If a comparison is made between these speeds and those used in milling and turning with tools made from high-speed steel, it will be seen that speeds ranging from three to five times as great can be employed in this generating process, thus permitting high production rates to be obtained.

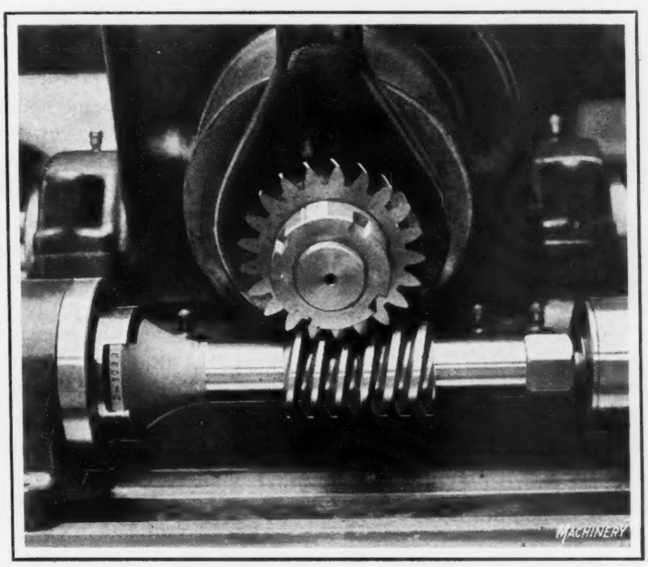


Fig. 2. Close-up View of a Thread-generating Cutter producing Two Double-thread Forms

The principle of thread generation, as briefly outlined in the foregoing, demands three main conditions in a machine intended for generating threads. First, the cutter must be rotated in the proper relation to the work; second, there must be an arrangement for traversing the cutter longitudinally past the work; and third, provision must be made to compensate for the rolling motion of the cutter. As an illustration, if a generating cutter were geared up with a worm thread, the cutter would run satisfactorily with the thread, provided the cutter were not moved longitudinally. As soon as the

cutter was moved longitudinally, it would cut off the threads on the work unless there was some provision to compensate for the rolling motion of the cutter.

Features of the Design

Change-gears are provided for obtaining the proper ratio of rotation between the cutter and the work, and also for traversing the cutter along the work at the desired feed per revolution of the latter. Change-gears and a differential mechanism compensate for the rolling motion of the cutter.

In order to permit the cutter-slide, which is operated by means of a lead-screw, to be traversed in both directions, a reversing clutch is furnished on the main feed shaft. In cases where it is possible to finish the work at one pass of the cutter, the cutter may be traversed from right to left on the first part, and the next piece machined after shifting the reversing clutch so as to traverse the cutter from left to right. Thus the mechanism obviates the necessity of returning the cutter-slide to the starting position at the completion of each cut. As the cutter passes out of contact with the work, a tripping mechanism is operated to stop the machine.

The cutter-head is provided with trunnions which are retained in bearings in the cutter-slide, and so the head can be swiveled on the trunnions to elevate or lower the cutter relative to the work. The control of the head is through a depth bar, which is supported in a seat in a projection on the cutter-slide. Resting on this bar is a shoe or roll, as the requirements may demand, which is held in a rod that passes up through the head and is screwed into a worm-wheel, the latter being operated through a worm and hand-wheel for setting the cutter to the proper depth. The depth control bar can be made in various shapes so that roughing and finishing cuts can be taken on a part, or the bar can be made plain for taking only one cut.

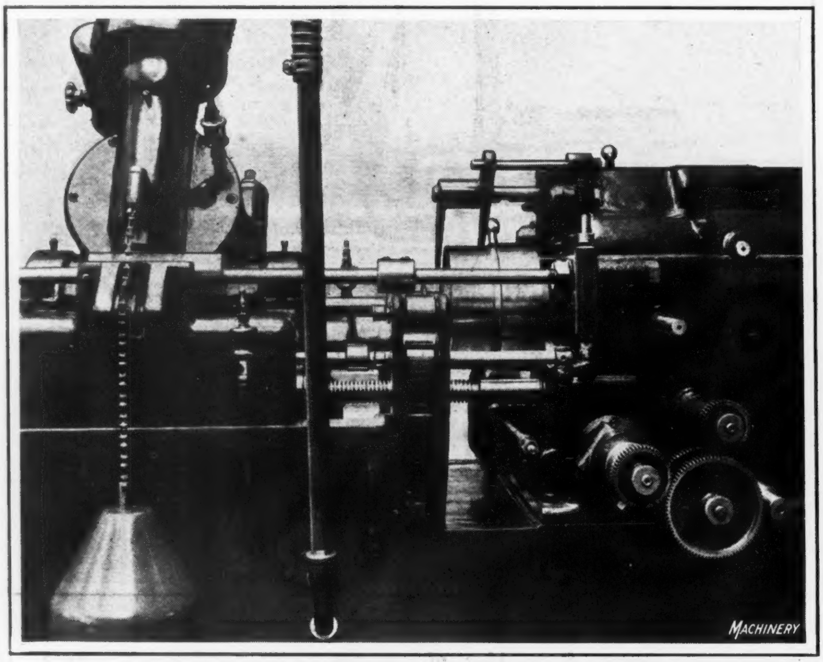


Fig. 3. Rear View of Thread Generator, showing the Driving and Tripping Mechanisms

Capacity of the Machine

This thread generator has been designed to handle a large range of work. On the No. 1 machine the maximum length of thread that can be cut is 12 inches; the maximum center distance, 18 inches; the maximum outside diameter, 4 inches; the maximum pitch, 5/8 inch linear or 5 diametral pitch; the maximum helix angle, 23 degrees; and the maximum pressure angle, 14 1/2 degrees. When provided with standard equipment, this machine will cut single, double, triple, and quadruple threads from 1/4 to 5/8 inch, or 6 to 16 millimeters, inclusive, linear pitch. By the use of a special worm and worm-wheel in the cutter-head, which may be substituted for the standard type, single threads from 0.050 up to and including 1/4 inch, or from 2 to 6 millimeters, inclusive, linear pitch, may be cut.

The application of the molding-generating principle to cutting threads on worms, hobs, taps, etc., by employing a Fellows helical gear-shaper cutter, has resulted in the development of a machine running at unusually high speeds.

LAPOINTE HYDRAULIC BROACHING MACHINE

A hydraulically driven pull-broaching machine known as the No. 3H has been recently brought out by the J. N. Lapointe Co., New London, Conn. The principal feature claimed for the new machine is the high production rates obtainable. For example, in using a six-spline broach, 1 5/8 inches in diameter and 48 inches in length, 175 pieces have been broached per hour. An efficiency of 93 per cent is claimed for the driving method. The cutting and return speeds of the draw-head are instantly adjustable to any rate from 0 to 25 feet per minute by manipulating the upright lever at the broaching end of the bed. This lever is pulled to the left to make the ram pull the broach through the work and to the right to cause the return of the draw-head.

The movements of the control lever are imparted through links and rods at the back of the machine to a rack and pinion mechanism which operates the valve of a Hele-Shaw high-speed rotary pump driven by a constant-speed 7 1/2-horsepower motor running at 860 revolutions per minute. The armature shaft of the motor is connected directly to the driving shaft of the pump through a tooth clutch. When the control lever is operated to the left, the pump valve is opened to deliver oil under pressure into the forward end of the machine cylinder and force back a piston attached directly to the draw-head ram. Conversely, when the control lever is pushed to the right, the pump valve is opened to admit oil into the cylinder in back of the piston and give the return stroke to the draw-head.

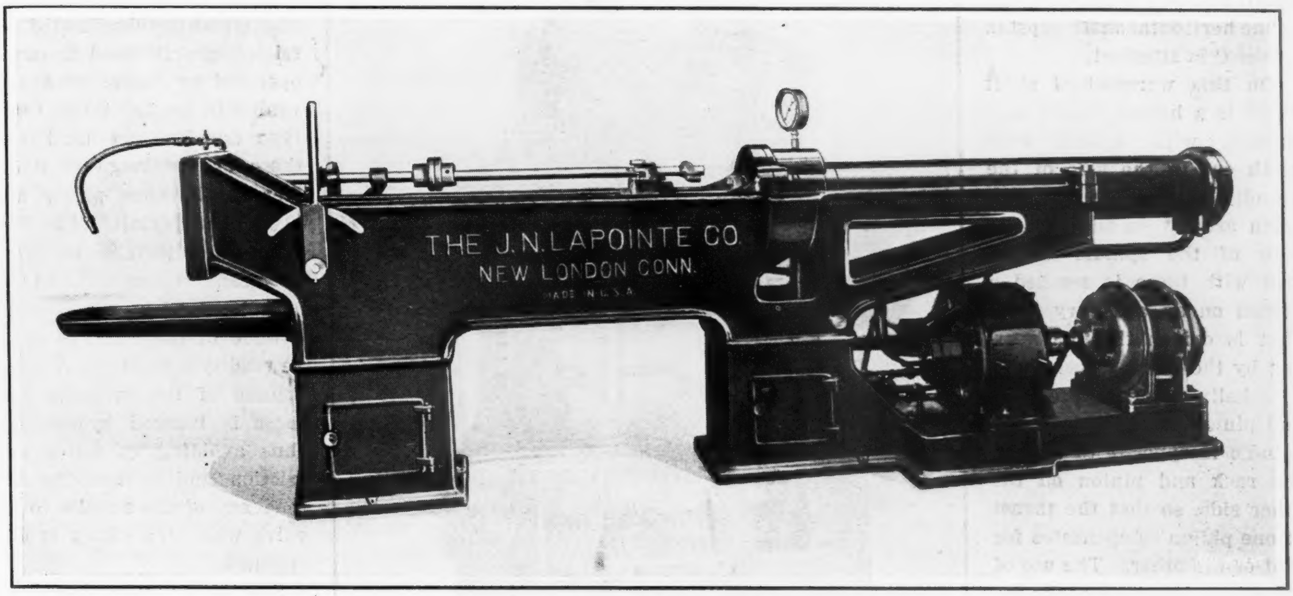
The pressure developed depends upon the extent that the pump valve is opened to admit oil into the cylinder. A maximum pressure of 1500 pounds per square inch can be produced, and the machine has a rated capacity of 32,000 pounds pulling force. The central shaft of the pump is hollow and functions as a valve for discharging oil into the cylinder, having both inlet and exhaust ports. The pump may also be driven by belt instead of a motor.

Supported by upright brackets at the rear of the machine is a longitudinal rod that is connected to the pump control mechanism in such a way that it is moved with the control lever and in the same direction. At each end of this rod there is a projecting dog which the draw-head trips at the end of its stroke to throw the control mechanism and the pump valve into the neutral or inoperative position. This insures that the machine will stop at the desired point without any effort on the part of the operator, and provides a convenient means of limiting the length of stroke.

A special device consisting of a fixed and an adjustable collar on this control rod may be set to guard against the use of too fast a cutting speed. The adjustable collar can be made to contact with the left-hand bracket supporting the rod when the lever has been moved the proper distance to the left to open the pump valve the desired amount, the collar

then preventing any further movement of the lever. This device may be locked by a production foreman after he has set the adjustable collar for a predetermined maximum speed, so that the machine operator cannot change it, as he would be likely to do if he were paid on a piece-work basis. The setting of this collar does not interfere with a full-speed return of the draw-head. Automatic valves also guard against too great a broach pull, and a direct reading gage indicates when a broach has become dull and should be re-sharpened. These two features considerably lessen tool breakage.

Oil for the pump is contained in a reservoir in the pump base, to which it is returned from the cylinder. Any small leakage that may occur in the pump serves to lubricate its revolving and sliding members. Cutting lubricant is supplied to the work from a small geared pump driven by the motor. The lubricant is drawn from a reservoir in the front leg of the bed, and drains back into the reservoir after it is used. The drip pan at the front of the machine may be swung aside when it interferes with the broaching of large work. The draw-head is equipped with the regular Lapointe pull-bushing holder, and slides on square ways. Brass shoes, which are readily replaced when worn, take all wear resulting from the sliding of the head.



Lapointe Single-unit Type Hydraulically Operated Broaching Machine

This machine has been made considerably stronger than the previous No. 3 machines, so as to insure against any vibration or chatter due to broaching parts at high speeds. The standard equipment of the machine consists of 1½-, 2-, and 2½-inch reducing bushings, and ⅜-, ⅝-, ¾-, and 1-inch pull-bushings. Some of the principal specifications are as follows: Maximum stroke of draw-head, 56 inches; diameter of hole in faceplate, 5 inches; vertical adjustment of draw-head, 1⅝ inches above and below the center; floor space occupied, 13½ feet by 27 inches; and approximate weight, 3500 pounds.

FOOTE-BURT TWO-SPINDLE HIGH-DUTY DRILLING MACHINE

For the production drilling of hubs, gears, connecting-rods, links, and similar parts, the Foote-Burt Co., Cleveland, Ohio, has developed a two-spindle high-duty drilling machine of unusual construction. From the illustration it will be seen that the frame consists of a base unit and a head unit, between which pedestals of different heights may be inserted to bring the spindle noses as close as possible to the lower face of the head unit for the particular job on which the machine is to be used. Rigidity of construction is obtained by using heavy trussed iron castings, and by employing four 2-inch bolts which extend from the top to the bottom of the machine, to tie the different units together.

This machine is built in two sizes, which handle practically the full range of a miscellaneous line of products such as mentioned. In addition to using this machine simply for drilling, it may be employed for the performance of such successive operations as drilling and spot-facing, or drilling and reaming, and by the use of auxiliary multiple-spindle heads on the spindles, it may also be adapted to the multiple drilling of bolt-holes in flanges and work of a like nature.

When two similar operations are performed simultaneously, like drilling holes in two pieces, a two-station fixture is mounted on the work-table to increase the rate of production. Thus, while two pieces of work in one station are being drilled under the two spindles of the machines, finished pieces may be removed from the other station and new pieces set in place. In such a case, the work-table is indexed 180 degrees between each drilling.

When successive operations like drilling and spot-facing, or drilling and reaming, are being performed, a three-station fixture is used. This fixture is indexed 120 degrees between each operation, the work being set up at one station during the time that the first operation is progressing at the second station and the final operation at the third. The large hand-lever seen at the front of the base is employed to engage or disengage a lock-bolt which secures the table in the various indexed positions. In work on which two successive operations are performed on the same piece, it is important that the two spindles operate independently of each other, because the proper speeds and feeds for drilling and counter-boring, for instance, are different. On this machine the speed and feed mechanisms for the two spindles are entirely independent of each other.

Driving Mechanism

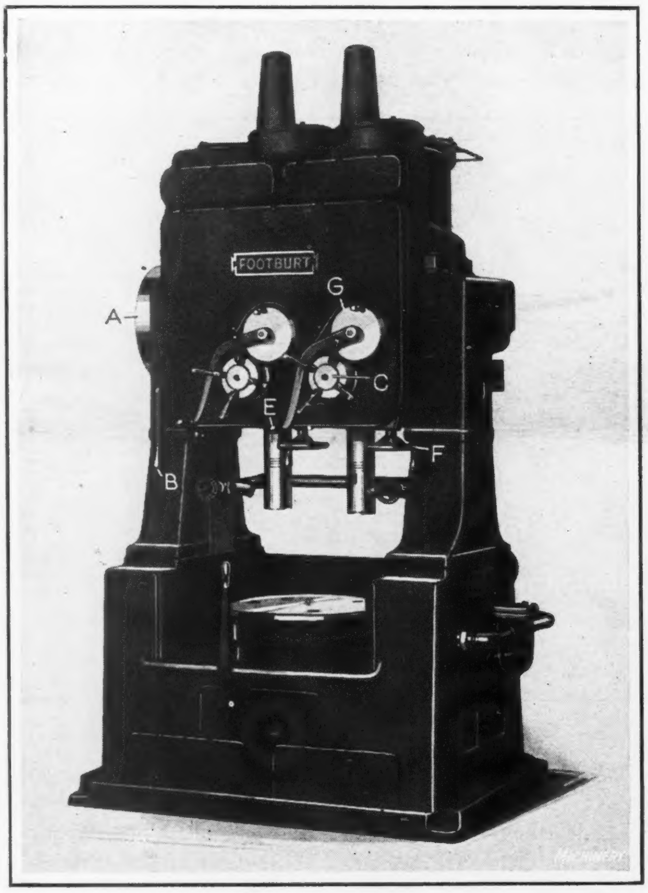
Power is delivered to the machine by means of a single pulley *A*, which is provided with a friction clutch operated by manipulating lever *B*. From the pulley shaft, motion is transmitted through two sets of forged-steel bevel gears to two auxiliary vertical shafts, each of which serves one of the two spindles on the machines. As the mechanisms for the two spindles are exactly the same it will be sufficient to describe one of them. From the auxiliary shaft, take-off gears transmit power to a pair of forged-steel helical gears, the second of which drives the spindle. Different speeds are obtained by changing the ratio of the take-off gears, these being provided in sets to furnish spindle speeds from

43 to 304 revolutions per minute. Through the use of special ratios, however, speeds up to 500 revolutions per minute may be obtained. As this machine is intended for long runs of production work, it will be apparent that this provision for changing the rate of spindle rotation is adequate. On the other hand, the machine possesses ample flexibility to adapt it for a wide range of work, and it is intended for such use rather than for one particular line only.

Arrangement of the Feed Mechanism

Power is taken from the spindle through a pair of take-off gears to drive the feed mechanism, and as in the case of speed changes, different rates of feed are obtained by changing the ratio of the feed take-off gears. This arrangement affords a range of feeds from 0.006 to 0.168 inch per spindle revolution, practically any desired rate being available for any particular job. However, other feeds can also be obtained. The feed take-off gears transmit power to a vertical shaft, at the lower end of which there is a worm meshing with a worm-wheel mounted on a horizontal shaft, and at the forward end of the horizontal shaft, capstan wheel *C* is attached.

On this worm-wheel shaft there is a helical pinion that meshes with helical rack teeth cut in the side of the spindle sleeve. Similar rack teeth are cut on the opposite side of the spindle sleeve, and with these is meshed a pinion on an auxiliary shaft that is driven through gearing by the worm-wheel shaft. The helix angle of the rack and pinion on one side of the spindle is opposite to that of the rack and pinion on the other side, so that the thrust of one pinion compensates for that of the other. The use of helical pinions and racks for feeding the spindle insures a smooth feeding movement.



Foote-Burt High-duty Machine designed for Production Drilling

Hand Feeds for the Spindle

In addition to the power spindle feed, a hand feed may be obtained in either of two ways. On the worm-shaft that drives the feed mechanism, there is a positive jaw clutch, which can be engaged or disengaged by operating lever *E*. One method of obtaining a hand feed is by disengaging the clutch and turning handwheel *F*. If it is desired to obtain a quick traverse movement of the spindle, this is accomplished by pulling forward any handle of the capstan wheel *C* to release the clutch on the worm-wheel, thus enabling a hand movement of the spindle to be obtained directly through the pinions that mesh with the rack teeth on the spindle. Disk *G* is geared to the feed mechanism, so that it revolves at the same rate as the pinion. On this disk there is a knock-out plug, which can be set to contact with lever *E* and trip the clutch at any predetermined point.

As the machine is intended for operation under severe conditions, provision has been made for delivering a copious flow of coolant to the work. A centrifugal pump having a capacity for delivering forty-five gallons of fluid per minute to the work through a 1¼-inch pipe is furnished. The reservoir is in the base of the machine and holds over two barrels of coolant, so that with the coolant in continuous circulation, there is no danger of its temperature rising to a point where cooling of the tools and work will not be efficient. A strainer is provided in the pipe line, as seen at the right in the base unit, and the coolant passes through another strainer at the point where it returns into the reservoir. These strainers insure the removal of all chips and other foreign matter from the fluid. A guard similar to that at the back of the work-table is placed at the front of the machine when it is in operation, to prevent the coolant from splashing on the operator and floor. This guard was removed at the time the photograph was taken in order that an unobstructed view of the table would be obtained.

BARDONS & OLIVER TURRET LATHES

A line of turret lathes intended for machining brass, iron, and aluminum parts, is being placed on the market by Bardons & Oliver, Cleveland, Ohio. These lathes are made with either a plain or a friction-geared head, and with or without an automatic chuck. The clutch mechanism of the friction-geared head is easily operated by means of a conveniently located lever. Cone-type frictions are used, and these are as large in diameter as the cone pulley and head gear permit. The frictions are adjustable for wear by means of ring nuts on the spindle, which are located outside of the cone, so as to be readily accessible. A quick release of the gripping surfaces is insured by springs, thus avoiding excessive end friction and overcoming the tendency of the spindle to revolve when the clutch is disengaged.

Special attention has been given to insure adequate lubrication of the headstock members. The spindles of machines not equipped with an automatic chuck are threaded at the rear end to permit air chucks to be attached. The spindle nose regularly has two straight bearings, one at the outer and one at the inner end, in addition to the thread. This construction is said to insure true-running chucks, faceplates, and fixtures. However, the spindle nose can also be made to suit the customer.

The cut-off rest, as regularly furnished, is provided with a lever feed for the cross movement on the 13- and 15-inch machines, and with a screw feed on the 18-inch size. A screw feed can also be furnished on the 15-inch machine. Side wear of the cut-off slide may be compensated for by means of a gib locked to the saddle. The cross motion of the slide is accurately regulated by two stop-screws, one at the front and the other at the rear of the machine. The screw-feed rest is provided with a micrometer dial in addition to the stop-screws. Means have been provided for taking up wear of the rack and pinion on the lever-feed rest. A hand longitudinal adjustment with a micrometer dial is regularly furnished for both types of rests. The rest is guided along the bed entirely by the front way to which

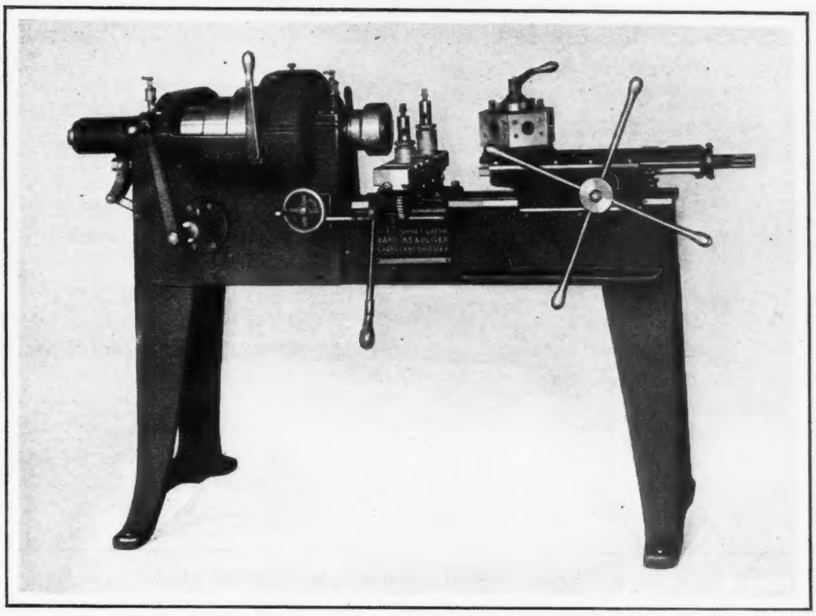


Fig. 1. Bardons & Oliver Turret Lathe intended for machining Brass, Iron, and Aluminum

the saddle is gibbed. Cut-off toolposts can be furnished in any one of four types. There is a plain round toolpost which has an adjustment for height, and swivels in a horizontal plane; a round toolpost with a base similar to that mentioned, except that the base has an extension to provide for an auxiliary clamping bolt; a square toolpost, which does not swivel and is adjustable for height by means of toothed wedges; and an open-side toolpost, convenient for working close to the chuck, which has a vertical adjustment and does not swivel. A vertical or under-cut forming tool slide can be furnished in place of the cut-off rest for turning irregular castings of circular cross-section by the use of forming tools. Means are provided for making all necessary adjustments. The forming of such parts is done by imparting one motion of the lever or screw, the tool taking a tangential cut on the work.

The turret is indexed automatically at the backward movement of the turret slide. It will be noticed that the bearing for the slide is extended beyond the front end of the saddle, so as to furnish a support for the slide through practically all of the usual working travel. This construction also permits of bringing the bearing close to the cut-off slide. The vertical turret locking bolt is placed at the front of the turret slide, as shown in Fig. 2, and enters hardened and ground taper bushings located in the turret as near the periphery as possible. Alignment of the turret holes with the spindle is maintained horizontally by means of two taper gibs, and vertically by means of a taper frame.

The turret stud has a hole through it in line with the hole through the spindle, to allow long stock to pass clear through the turret. This stud is used only for clamping the turret and does not take the thrust of the cut, a taper projection on the bottom of the turret, which fits an adjustable split ring in the slide, being provided for this purpose. The turret is tightened in this taper thrust bearing when clamped by the binder handle. The nut and spool in the center of the turret hold the turret to its seat on the slide. The nut is readily accessible for adjustment. An independent stop is provided for each turret face, the revolving type of stop-screw carrier being used. The stop-block may be quickly moved to one side when it is desired to feed a tool further than the block allows.

The automatic chuck is easily operated by means of the long vertical lever near the front of the bed, which actuates a patented mechanism of levers and links to give ample power for gripping the work in the collet. The three-step wedge, seen in Fig. 3, allows for a slight variation in the diameter of the work. When the collet is gripping the nominal size of stock, or, in the case of castings or forgings, when it is gripping the size corresponding to the majority of pieces, the fingers usually rest on the middle step of the wedge. Then, if the stock or piece is under-size, the fingers should rest on the largest step; and if over-size they should rest on the smallest. The gripping power of the collet is regulated by turning the threaded ring or adjusting nut which receives the thrust of the finger-holder, the latter

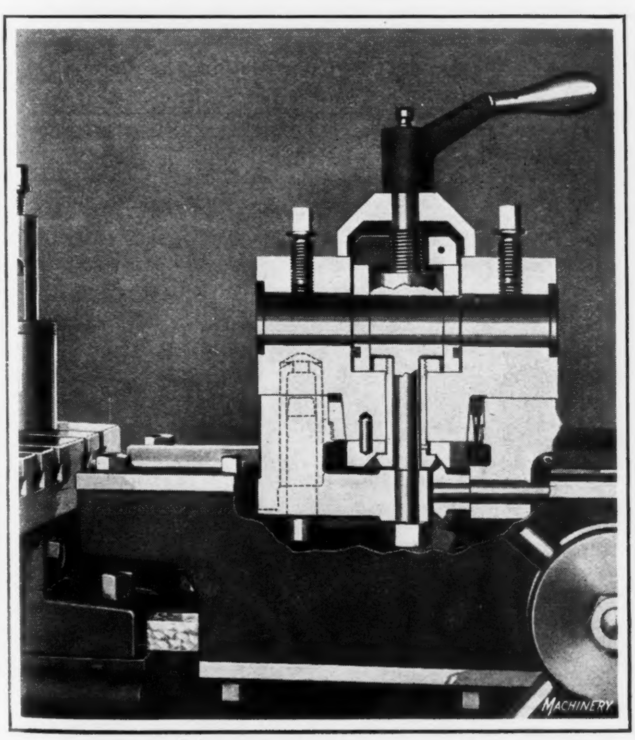


Fig. 2. Sectional View of the Turret, showing the Indexing and Locking Means and Hole through the Turret

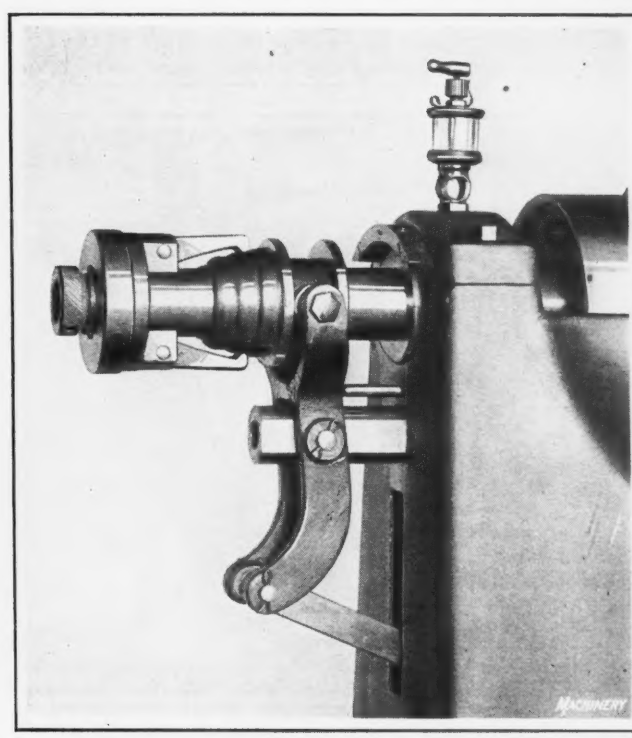


Fig. 3. Three-step Wedge which compensates for Variations in the Diameter of Work

being free to move the spindle. The adjusting nut is locked by means of a taper bushing or binder screw at the rear of the spindle.

For holding castings, forgings, or stampings, which are larger than the capacity of the bar stock collets, a hinged-type extra-capacity collet can be supplied. This collet can be furnished with either a push-out or a draw-back mechanism. For second-operation work, it is often desirable to have machines equipped with a draw-back automatic chuck, instead of the push-out type. On these machines, the additional parts necessary to change from the push-out to the draw-back chuck can be easily applied to the standard automatic chuck spindle. This line of lathes may also be equipped with a wire feed, power feed for the turret slide, power cross-feed for the cut-off slide, and a set-over turret slide and saddle.

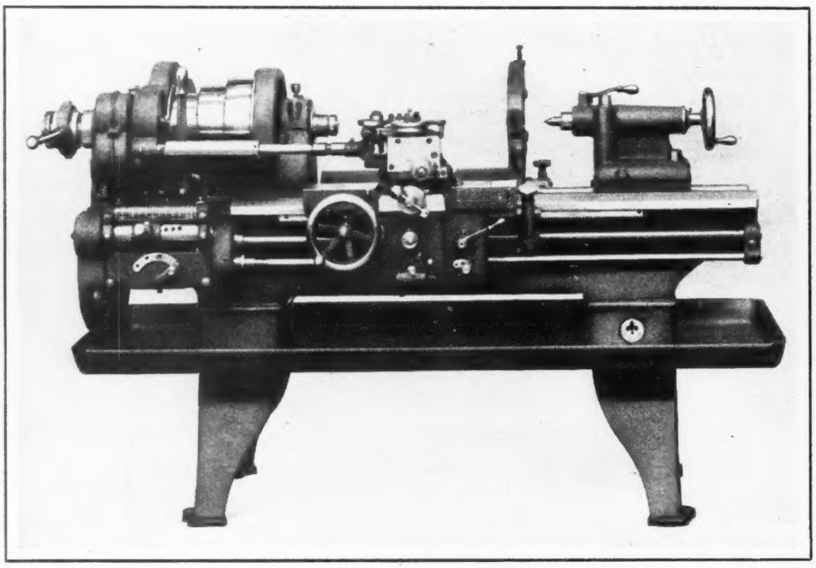


Fig. 1. LeBlond Fifteen-inch Heavy-duty Tool-room Lathe

LEBLOND HEAVY-DUTY TOOL-ROOM LATHE

A 15-inch heavy-duty tool-room lathe is now being introduced to the trade by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. This machine is similar to the lathes described in April MACHINERY except that it may be equipped with a cone-type headstock having either a hand- or a lever-operated draw-in attachment and chuck, a new universal relieving attachment, and a pan bed. This lathe may also be supplied with either a geared head, or a belted constant-speed or geared variable-speed motor drive. The lever-operated draw-in attachment and chuck is quicker and stronger in action than the handwheel type, and is preferable when a quantity of pieces is to be run; but the handwheel type is satisfactory for average tool-room service.

The spindle nose is furnished with a hardened closer in which is fitted a standard draw-in collet or spring chuck which is closed on the work by means of the handwheel at the rear end of the spindle on the hand-operated type, or by means of the lever on the lever-operated type. Either attachment can be supplied with any size collet from ¼ inch to 1 inch, the sizes increasing in increments of 1/16 inch.

The universal relieving attachment can be applied to both cone- and geared-head lathes. By means of two cams any relief from 0 to ¼ inch can be obtained, and practically all work within the range of the attachment can be handled without angularity of the knuckle joints. External, cylindrical, internal, end, side, and angular relief may be easily accomplished, and spiral relief can also be obtained by employing a special driving shaft and sleeve. The taper attachment may be used in connection with relieving operations.

The attachment is driven from the headstock through interchangeable spur gears which are arranged on a quadrant, the attachment in no way interfering with the use of the lathe for ordinary work. The drive is transmitted to the actuating mechanism on the tool-slide through a telescopic shaft. The tool-slide is substituted for the regular compound rest and incorporates the same swivel feature, thus enabling the operator to swivel the slide to the proper angle for obtaining angular, side, and end relief. Graduations facilitate setting the slide to the desired angular positions. The drive to the actuating mechanism is through a pair of hardened miter gears, one of which is keyed to the shaft of the left cam seen in Figs. 2 and 3. The driving gear can be swiveled about the center of the driven gear due to its being mounted in a swivel bracket which can be conveniently clamped. Because of this construction the driving shaft

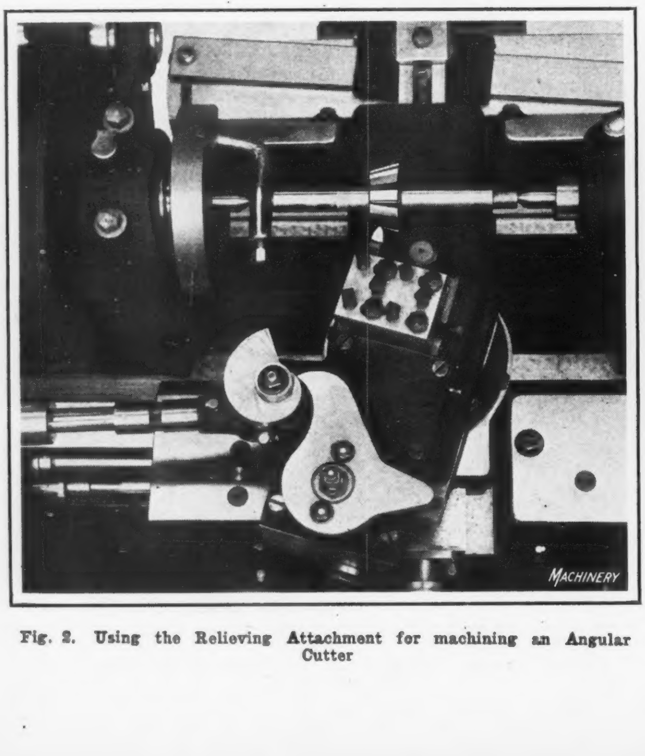


Fig. 2. Using the Relieving Attachment for machining an Angular Cutter

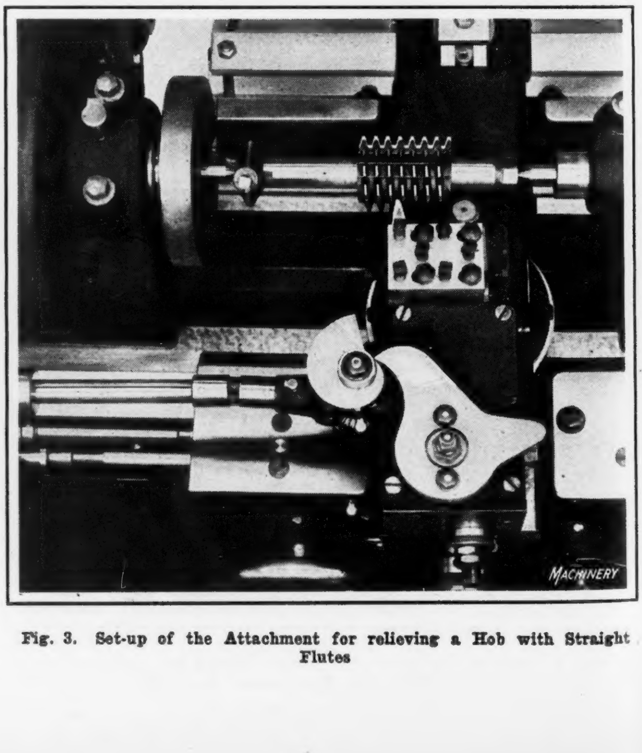


Fig. 3. Set-up of the Attachment for relieving a Hob with Straight Flutes

usually remains straight, regardless of the angular setting of the tool-slide, and so angularity of the knuckle joints is obviated.

The driving cam revolves constantly and imparts an oscillating motion to the larger follower cam at the right, the latter being mounted on a vertical eccentric shaft which may be adjusted relative to the follower cam by means of the square milled on the upper extension of the shaft. This eccentric shaft is oscillated under the influence of the master and follower cams and imparts a reciprocating motion to the tool-slide by means of the eccentric that is formed on the shaft and a rod that connects it to the tool-slide. The motion imparted to the eccentric shaft is constant, and so the variation in the stroke of the tool-slide is accomplished by adjusting the eccentricity of the vertical shaft in relation to the follower cam. It is evident that as the line of eccentricity approaches parallelism with the ways of the tool-slide, the stroke of the slide is decreased, and that when adjusted to the maximum throw of the eccentric, the stroke of the slide is lengthened to give the greatest amount of relief.

The regular range of adjustment permits relief from 0 to ¼ inch, as already mentioned, and requirements beyond this range can be taken care of by using special cams. Adjustment for relief is easily made, as the follower cam is graduated to facilitate setting it. A heavy coil spring maintains contact of the follower cam with the driving cam when the low portion of the latter is reached, thus returning the slide forward at that time. The tool-slide is furnished with a three-position tool-block which is adjustable laterally by fine-thread screws. An operation which consists of relieving an angular cutter is illustrated in Fig. 2, the attachment being swiveled to the proper angle and the taper attachment connected to the cross-slide. The attachment could also be swung around to relieve the side of this cutter. In Fig. 3 the attachment is being employed for relieving a hob with straight flutes.

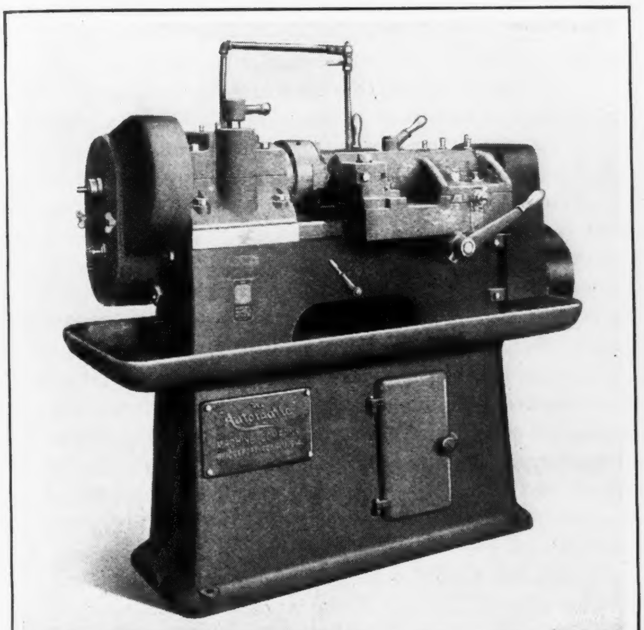


Fig. 1. Coulter Duplex-hob Thread-milling Machine for Wrench Jaws

COULTER THREAD-MILLING MACHINE

A machine in which two hobs are employed for milling threads on pipe-wrench jaws has recently been developed by the Automatic Machine Co., Bridgeport, Conn. The threading of wrench jaws is usually peculiarly difficult, and hard on the machines and component parts used, because the surfaces to be threaded are interrupted, the section is rectangular in form, and the threaded surfaces are curved to a diameter equal to the width of the section. In designing this machine, special consideration was given to ample rigidity, sufficient weight, adequate bearing surfaces, large milling spindles, and sturdy milling arbor supports. An important feature enabling high production to be attained is the use of two hobs which are mounted parallel to each other and directly opposite, as illustrated in Fig. 2, so that only one-half a revolution of the work is required to complete the threading of a rough-trimmed forging.

Power is delivered to the machine through a single pulley, and is transmitted to the work and milling spindles through spiral gears. Variations in feed are obtained by change-gearing, and lead is given to the thread of the wrench by means of a cam which has a wide face working against a bronze shoe which is fastened adjustably to the milling-spindle carriage and held in contact with it by weight. The parallel milling spindles are independently and collectively adjustable, so that each cutter may be located exactly the same distance from the center of the work and accurately set for sizing it. A tail-center is located between the milling-spindle housings and operated by means of the hand-lever on the front of the machine at the right and the clamping handle on top.

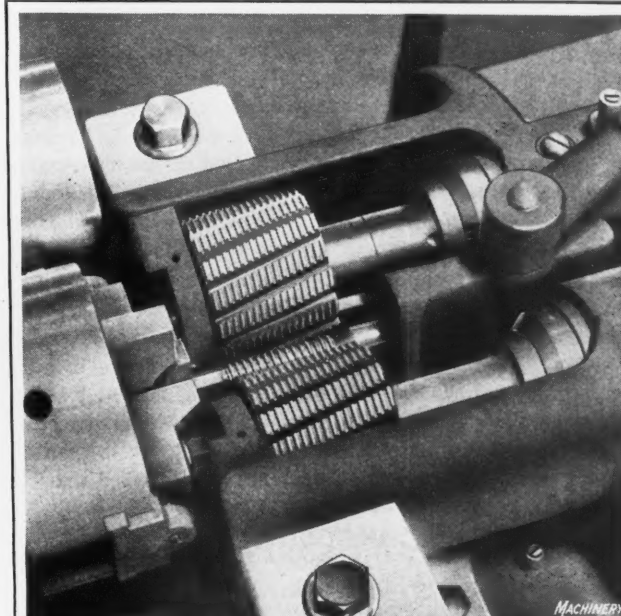


Fig. 2. Close-up View, showing the Arrangement of the Two Hobs

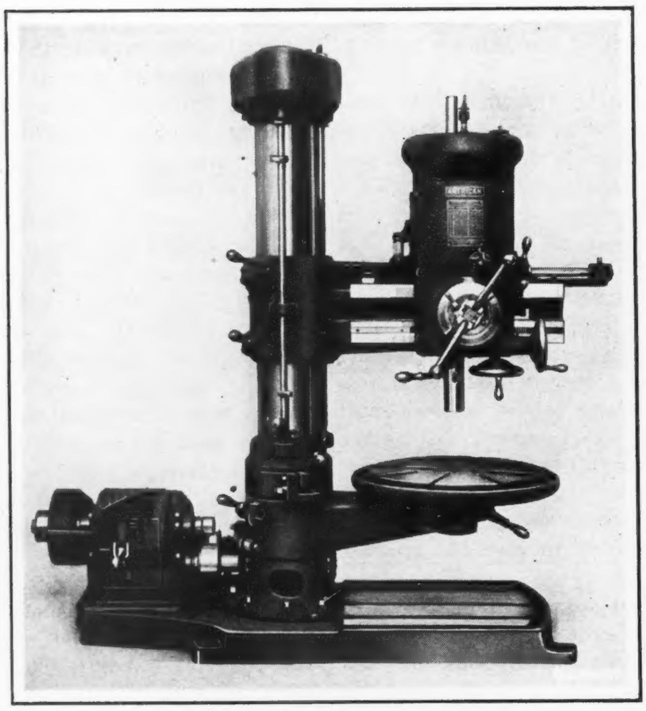
The small handle at the front directly under the chuck is used for starting the machine, and the handle on top of the work-spindle is employed for operating the chuck through a plunger in the center of the spindle. By this arrangement two tool-steel levers fulcrumed in the steel chuck body are made to act on master jaws of the chuck into which are fitted adjustable work-holding jaws. Between the jaws and at right angles to them is fitted a jig for supporting and aligning the head end of the wrench jaw without requiring it to be centered. The base has a liberal oil-pan beneath which is an oil reservoir and a cabinet for storage purposes. An oil-pump and piping are regularly supplied. As an example of the production possible, eighty-five 14-inch wrench jaws were completely threaded during a trial in one hour floor-to-floor time.

AMERICAN RADIAL DRILLING MACHINE

A high-speed radial drilling machine similar to one described in May, 1919, MACHINERY, except that it is built in 2- and 2½-foot sizes, has been added to the line of the American Tool Works Co., Cincinnati, Ohio. The head of

this machine is of the double-drive, back-geared type, which provides two rates of spindle speed for each speed obtained through the cone pulley or six-speed gear-box with which the machine may be equipped. There are twelve speeds, in geometrical progression, ranging from 50 to 900 revolutions per minute, which adapt the machine to a wide range of drilling, tapping, and facing operations. The head is enclosed by an oil-tight housing.

One of the improvements of this machine is in the tapping attachment, the entire mechanism of which is fully enclosed and runs in oil. The gears are made from steel forgings and are bronze-bushed, and the entire unit is mounted on a steel sleeve which runs on ball bearings. The speed box is of the cone-and-tumbler type, and has an automatic silent-clutch auxiliary drive which keeps the shafts and gears running while changes are being made, so that much of the shock caused by the engagement of gears is eliminated. This forms a positive drive which is used only during speed-changing and never for a working speed. The gears of the tumbler mechanism are cut with B. & S. 20-degree cutters, and are carburized and hardened. A spring device located between the speed box and the column driving gears prevents shocks from being transmitted to the speed box parts.



American Radial Drilling Machine

Four feeds are provided in geometrical progression, ranging from 0.004 to 0.016 inch per revolution of the spindle. The feed mechanism is protected against shocks and excessive stresses by a friction clutch which forms the connection between the mechanism and the spindle. This clutch is an expanding band type, quickly adjustable to the desired tension.

DUPLEX ROTARY SURFACE GRINDER

An improved Osterholm duplex rotary grinding machine has been brought out by Williams, White & Co., Moline, Ill. This machine was developed to automatically surface-grind thrust washers, clutch disks, bearing races, and many other parts that can be individually or collectively chucked within a diameter of 12 inches. It is primarily a production machine, and so it has been heavily designed to permit a large amount of metal to be removed in a short time. The machine automatically completes one cycle after the work is chucked and the machine started.

In Fig. 1 the machine is shown in the loading position with the rotary chucks at rest. When it is started, the rotary chucks are raised to the position shown in Fig. 2, and locked by the first fractional rotation of the cam on the left-hand side of the machine. Further rotation of the cam advances the abrasive wheel toward the work, the rate at which the wheel moves forward being determined by the shape of the cam. Heavy cutting is accomplished in the first part of the cycle, allowing ample time during the remainder of the cycle for the wheel to cut itself free, true the surface being ground, and produce a finish of the desired quality. On the completion of the cycle the chucks automatically drop to the loading position and the machine stops.

The automatic features of this duplex grinder make it possible to operate the machine with comparatively unskilled labor, and where the combined chucking and unloading time is considerably less than the operating time, it is recommended that one operator run two or more machines. Ample provision has been made for supplying coolant, a large stream of liquid being pumped through the wheel-spindle and an additional stream through each of the work-spindles. The water introduced in the rapidly revolving wheel-spindle cascades over the brim of the wheel and prevents loading of the wheel. The water coming from the work-spindles at the rear of the work has a tendency to keep down the temperature of the work and thus prevents burning and warping. When the machine is in the operating

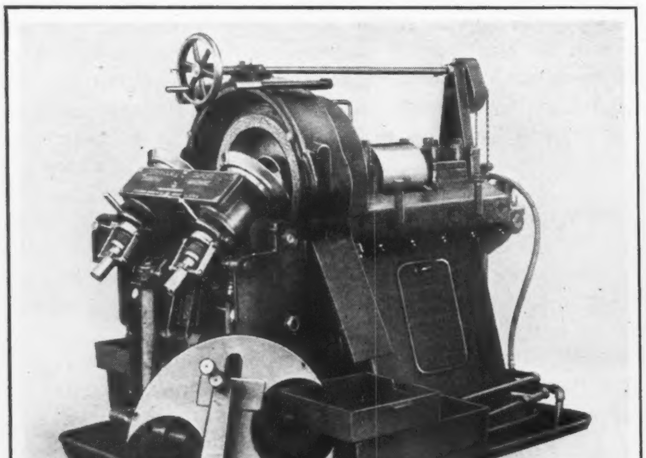


Fig. 1. Osterholm Duplex Rotary Surface Grinding Machine

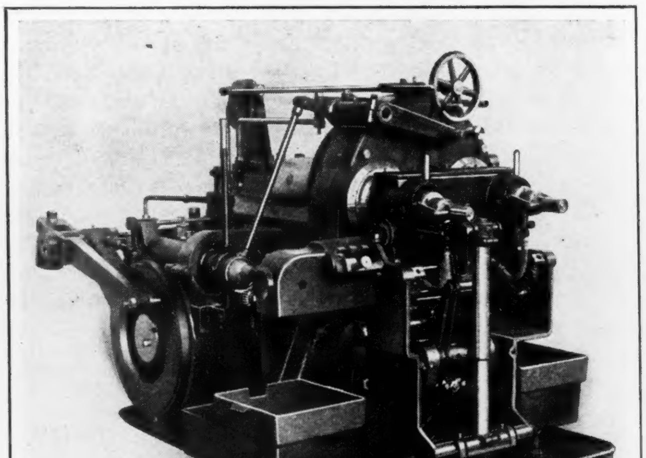


Fig. 2. View of the Machine with the Chucks in the Operating Position

position, the wheel chamber is practically sealed and hence the operator, the machine parts, and the floor remain as dry as if no water were used.

Mechanical chucks, either pneumatic or hand-operated, are recommended for use on the machine, because such parts as thrust washers can be ground with accurate parallel sides in two operations. Expanding or contracting collets are operated through toggle links by means of the handles seen in the illustrations, and these form a convenient means of chucking. Magnetic chucks may also be used.

Ring grinding wheels 20 inches in diameter are employed, the depth and rim thickness being varied to suit the work. The wheel is advanced by means of the handwheel on top of the water guard, to compensate for loss in grinding and dressing. This adjustment is calibrated in thousandths of an inch. The wheel dresser is mechanically driven and always in place. The cycle of the machine is varied by means of the change-gears on the left-hand side, and a three-step change-gear provides for rotating the wheel-spindle at from 900 to 1000 revolutions per minute. There are three chuck speeds ranging from 8 to 12 revolutions per minute. A cycle of the machine is completed in from twenty seconds to two minutes. The machine is lubricated by means of ring and chain oilers.

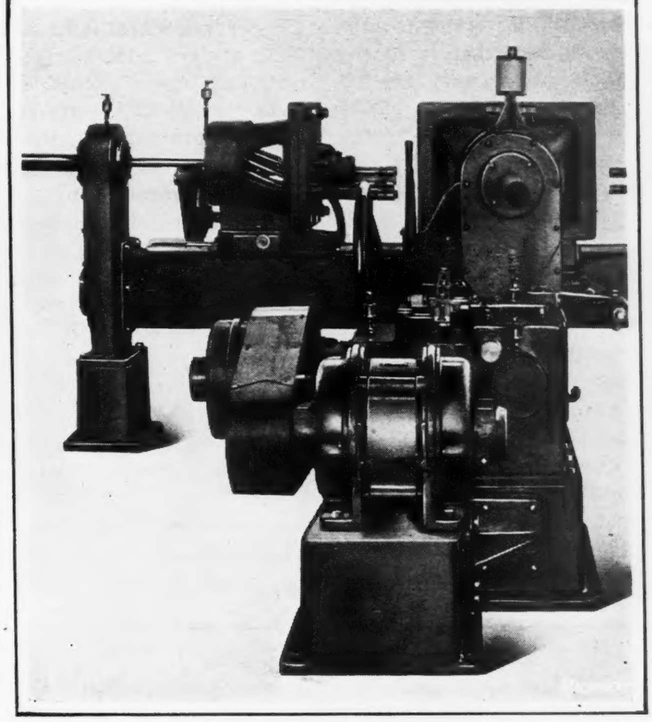


Fig. 2. Rear View of the Fox Tapping Machine

FOX THREE-WAY SEMI-AUTOMATIC TAPPING MACHINE

Holes can be simultaneously tapped in both ends and one side of automobile cylinder blocks in a three-way semi-automatic tapping machine recently developed by the Fox Machine Co., Jackson, Mich. From the front view of the machine, shown in Fig. 1, it will be seen that there are two side-heads which tap the holes in the ends of the block, and a rear head for tapping the holes in the side. The left-hand head has four spindles, and the right-hand and rear heads have six each. All spindles are mounted on patented cluster plates which are held rigid by arms doweled to the plates. The gearing and spindles in the heads are standard.

Power for driving all three heads is obtained from a 10-horsepower motor running at 1200 revolutions per minute, which is located at the back of the machine, as illustrated in Fig. 2. The power transmission from the motor to the driving clutch is through a silent chain. Reversing clutches are mounted on a shaft which extends to the front of the machine, and on this shaft is also mounted a sprocket which drives, through a chain, the spindles of the rear head. At the front end of the same shaft there are bevel gears which drive horizontal shafts; these shafts carry the motion to a chain sprocket at each end of the front column, from which the power is transmitted to shafts that drive the spindle gearing in the right- and left-hand heads. The rear view also shows the automatic reversing mechanism which is typical of Fox vertical tapping machines.

Change-gears are carried by each head to advance and return the heads along the bed in unison, at a speed corresponding to the pitch of the taps in the head. These gears can be changed to accommodate taps of different leads. The motion of the heads can be started, stopped, or reversed by means of the lever at the left of the table on the front side of the machine. A forward movement of this lever starts the taps revolving in the right-hand direction, the

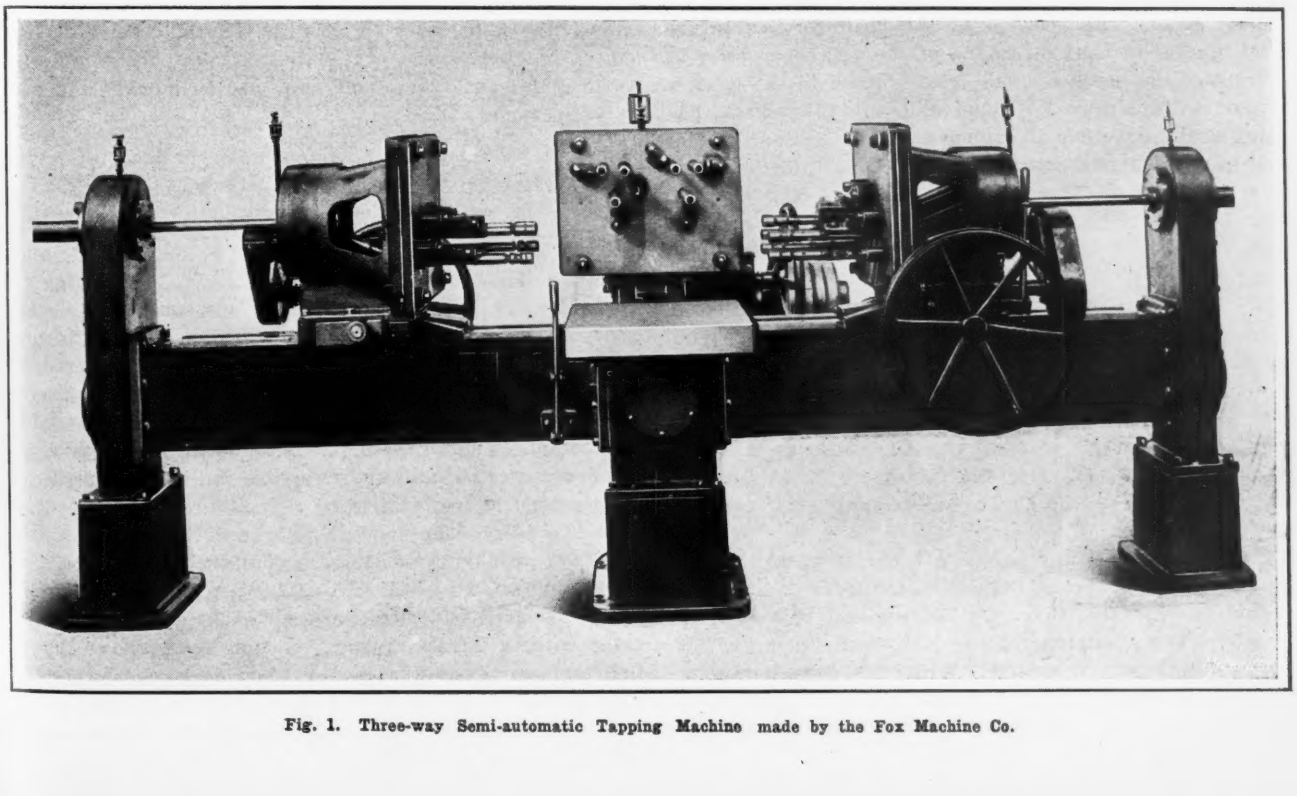


Fig. 1. Three-way Semi-automatic Tapping Machine made by the Fox Machine Co.

heads advancing at a feed corresponding to the lead of the taps, and thus insuring accurate threads. Reversing is automatic, the heads being returned at a feed that is in the same ratio to the tap lead as that in which they are advanced, without any assistance from the operator. They are automatically stopped when they have returned to the starting positions. The tapping speeds are about 20 feet per minute. This machine weighs about 6350 pounds.

REED-PRENTICE CUTTER GRINDER

A small universal cutter grinder capable of handling a large variety of small drills, milling cutters, and engravers' tools, has been lately developed by the Reed-Prentice Co., 677 Cambridge St., Worcester, Mass. With this machine, tools can be ground to a predetermined angle even by an inexperienced man. From the accompanying illustration, it will be seen that the machine is equipped with two wheels, mounted directly on the armature shaft of an enclosed motor. The motor regularly furnished is of 1/8 horsepower capacity, runs at 3400 revolutions per minute, and is intended for connection to any 110-volt, alternating-current, lighting circuit. One of the wheels is used in connection with a universal head, and the other is intended for free-hand grinding. The machine may also be furnished without the latter wheel. Both wheels are 4 inches in diameter.

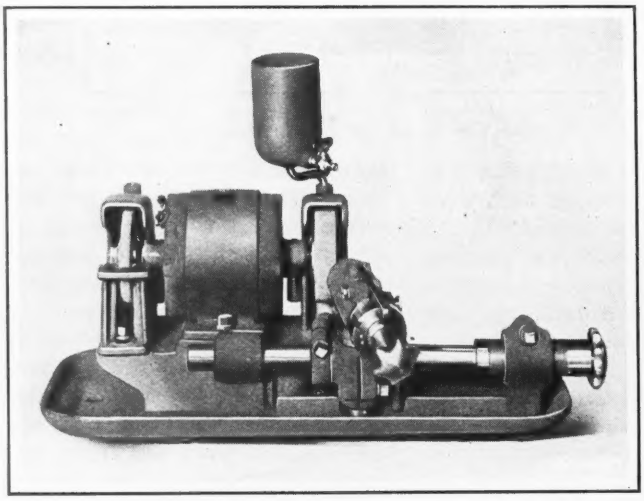


Fig. 1. Reed-Prentice Grinder for Small Drills, Milling Cutters, and Engraver's Tools

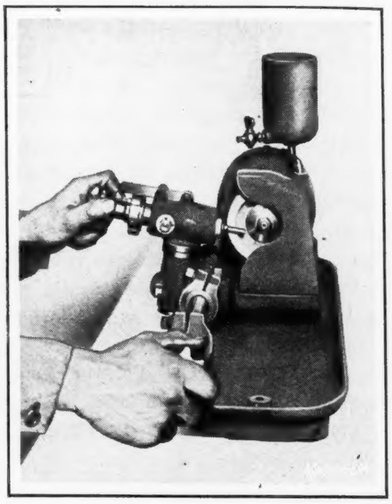


Fig. 2. Positions of the Operator's Hands in grinding a Cutter

The universal head provides for grinding tools at any desired angle. A swivel bracket which forms the lower part of the head is clamped on a bar mounted parallel to the armature shaft. One end of the bar is supported in a stationary bearing, while the other end is held in a bearing that provides for longitudinal adjustment. The head may be swiveled to any desired position, accuracy of a setting being facilitated by graduations on the circular flange. The position of the head relative to the swivel bracket is fixed by means of the clamping screw at the front of the bracket. The cutter-spindle in the head is arranged with a draw-bar collet and an index-plate. The handle of the draw-bar is extended for the convenience of the operator. After a cutter has been clamped in the collet, this handle is used for rotating the spindle.

Mounted on the bar at each side of the swivel head is a dog that extends downward, and directly under the bar, projecting upward from the oil-pan, there is a rib that serves to trip the dogs. The extension of the left-hand dog is on the rear side of this stop, while the extension of the right-hand dog is on the front side. The dogs are set to control the amount of rotation of the swivel bar in grinding a cutter. A knurled-head plunger located on the side of the head engages a series of curves in the cutter-spindle and provides a means of varying the distance between the end of the collet and the wheel. This often eliminates resetting the dogs.

On the inside of the index-plate there is a spring cam that contacts with a projecting pin on the front of the head. The cam is adjustable to give a longitudinal movement of the cutter-spindle ranging from 0 to 1/8 inch during a 180-degree rotation of the spindle. With this combination of horizontal movements and the rotating spindle, practically any amount of relief can be obtained on a cutter. The cam is so arranged, however, that the spindle can be rotated 270 degrees, which eliminates the necessity of setting a cutter in the collet in exact relation to its cutting edge. Practically any type of eccentric-relief cutter may be ground, and it is possible to experiment with the amount of relief best adapted to a particular class of work.

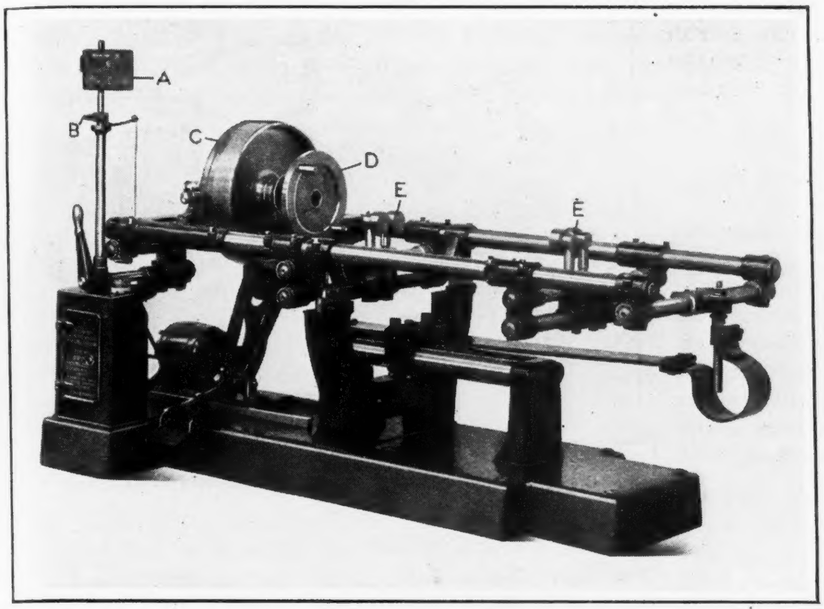
An index-plate having twenty-four divisions is regularly furnished to provide for grinding fluted cutters. In indexing a cutter, the lever on top of the head is lifted from the slot of the index-plate in which it happens to be, the spindle is rotated, and the lever is dropped into the desired slot. This lever is also used to hold the cutter-spindle from rotating as the collet is tightened, when a cutter is being clamped in place.

A fluted cutter is held in the collet with the flutes extending and with the index-lever in a slot in the index-plate. The cutter is set so as to give the tooth clearance desired, and the universal head is set at 90 degrees with the bar, so that the flutes are parallel with the side of the wheel. The dogs are then clamped on the bar to permit a rotation of the head about equal to the length of the flutes. Then with the operator's hands as illustrated in Fig. 2, the cutter is fed into the wheel by adjusting the swivel bar longitudinally with the right hand, and passed back and forth across the face of the wheel by employing the left hand. When one flute has been ground, the cutter is drawn away from the wheel, the index-lever lifted with the right hand, and the cutter indexed to the next flute. Fish-tail, eccentric-relief, twist drills, and other tools may also be quickly and accurately ground.

GISHOLT BALANCING MACHINE

A patented machine has been recently placed on the market by the Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis., for dynamic and static balancing, by making two corrections which are individually measured and located near the ends of the part. This machine applies the principles of dynamic and static balancing discovered by Dr. B. L. Newkirk. Duplicate parts, such as crankshafts, rotors, flywheels, and spindles can be rapidly balanced in production, as static balancing is rendered unnecessary, and the operator, who need not be highly skilled, has only a few simple steps to perform.

Briefly, the operation is as follows: The part to be balanced is placed on the machine and rotated above a "critical" speed of about 100 to 110 revolutions per minute. The drive is then released, and the upper scale of the calculating rule *A* set according to the amount of unbalance shown by an indicator on the post at *B*. A 10-ounce vernier weight is next placed according to the reading, on the large disk *C* at the end of the rotating parts. Finally, the part is rotated



Gisholt Precision Dynamic and Static Balancing Machine

again, and the lower scale of the calculating rule *A* set from the indicator *B*, to locate the point where metal should be removed from the part to correct the unbalance.

It will be obvious that the work is attached at one end to a headstock *D* and rests on rollers *E*, which are adjustable and mounted on ball bearings. The headstock and rollers are carried by a spring-mounted and pivoted frame. Because of the form and location of the springs, a free vertical vibration of the frame may take place with the pivot springs as a fulcrum point. In balancing a part, when the driving power is disengaged, the construction of the frame permits a gradual diminution of speed down to and through the free critical speed of the frame, and by observing the dial indicator *B*, the amount of correction required is accurately determined.

The weight on disk *C* is adjustable radially by means of the vernier, which reads to 0.01 inch, parts being exactly balanced when the weight is at zero. The disk may also be revolved to any desired angular position on its axis by reference to a protractor dial. When the correction has been arbitrarily applied, after rotating the part the first time, the second amplitude in the process bears a relation to the first dependent on the angle between the point of application and the point required. After determining and setting off this angle, a third run will check the result. When the first determination has been finished, the position of the work is reversed to complete the operation. The critical speed of from 100 to 110 revolutions per minute permits visual observation of the amplitude, and does not result in distortion of the work from centrifugal force. The machine is adapted to a wide variety of work, receiving bodies up to 25 inches swing, 32 inches between the support bearings, 48 inches over-all length, and up to 1000 pounds weight.

CHROBALTIC "FIRE-ARMOR" CONTAINERS

Containers that are not affected by temperatures up to 2350 degrees F. have been placed on the market by the Chrobaltic Tool Co., Railway Exchange Bldg., Chicago, Ill., for use in heat-treating high-speed steel tools by the "Fire-Armor" method in which the highest temperature required is 2215 degrees F. The term "Fire-Armor" has been given to the alloy from which the containers are made. This method of heat-treatment consists of heating the tools in a protected atmosphere to a predetermined temperature, holding them at this temperature for a predetermined length of time, cooling, and then tempering by again heating them to a specified temperature and holding them at that temperature for a certain length of time. This method is said to result in the full development of the cutting structure throughout the entire piece at the lowest possible temperature.

The tools are placed in a container, surrounded by charcoal and the cover put in place. In some large containers a pyrometer is inserted through the cover to the center of the box. The box and its contents, after preheating, are raised to that temperature point in the critical range at which the carbide transformation takes place, and held there a sufficient length of time to complete the change. It is said that this transformation is obtained between 2200 and 2210 degrees F. when high-speed steels are accurately held between these two temperatures in a protected atmosphere for a sufficient length of time. The length of time depends on the form of the piece, but in no case is it less than approximately forty-five minutes from the time the temperature has been reached. It is said that if the steel is held at this temperature for periods of from two to three hours, the structure is not altered, and that this method overcomes most of the irregularities found in high-speed steels after heat-treatment.

PANGBORN SAND-BLAST UNIT

A barrel sand-blast unit equipped with an exhauster and a cloth-screen dust arrester, and driven by direct-connected motors, has been placed on the market by the Pangborn Corporation, Hagerstown, Md., for cleaning small heat-treated, forged, stamped, or cast parts. This equipment is also intended for use in plants having only a limited production. Satisfactory ventilation and suppression and accumulation of dust is claimed for the unit. It is ready for operation by simply connecting it to a ventilating pipe and a compressed air line.

The outfit is made in two sizes, the No. 1 barrel being equipped with a drum 20 inches in diameter and 16 inches long and, with the arrester, occupying a floor space of 3 feet 3 inches by 7 feet; and the No. 2 barrel having a drum 30

Pangborn Barrel Sand Blast equipped with Exhaust and Dust Arrester

inches in diameter and 20 inches long, and requiring a floor space of 3 feet 7½ inches by 7 feet 5½ inches. The over-all height of both barrels is 8 feet 10 inches. The unit handles gray and malleable iron, steel, and brass castings, forgings, and stampings.

PORTER-CABLE CENTER-DRIVE LATHE

For simultaneously turning both ends of automobile axle shafts, camshafts, driving shafts, and similar parts, the Porter-Cable Machine Co., 1708-1712 N. Salina St., Syracuse, N. Y., has brought out the double-end center-drive lathe shown in Figs. 1 and 2. A headstock of heavy construction, having a hardened and ground spindle 6¼ inches long with a 2½-inch hole through it, is mounted at the center of the bed. The spindle is supported in large ball bearings, and is driven through a worm and worm-gear. The control of the machine is through a lever on the headstock, which is manipulated to operate a clutch on the driving shaft of the headstock. This clutch is of the expanding type, and is made sufficiently strong to permit of taking heavy turning cuts; it is arranged to stop the lathe the instant that it is thrown out. The shell of the clutch runs continually, being driven through a three-horsepower motor under the pan by a silent-chain drive.

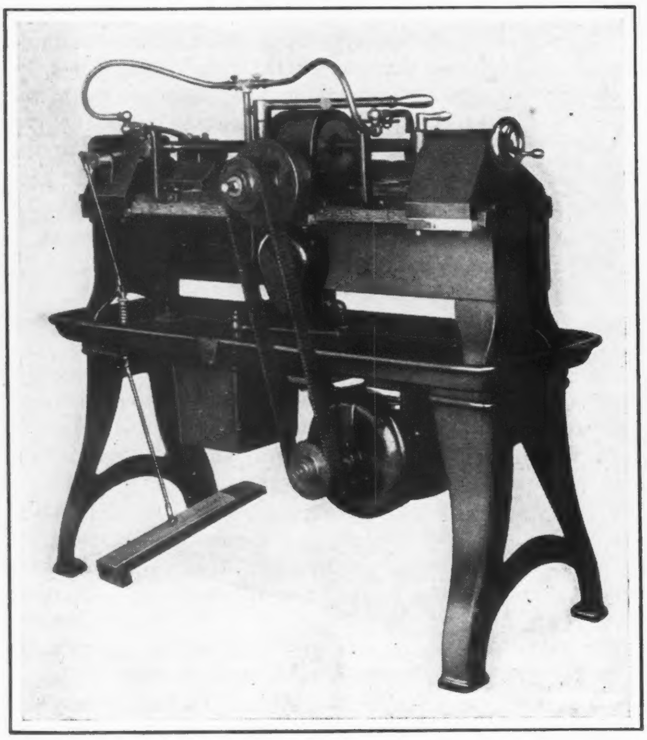


Fig. 1. Porter-Cable Center-drive Lathe for simultaneously turning Both Ends of Camshafts and Similar Work

The two tool carriages are operated by means of a hardened steel cam and roller. Important features of the carriages are that both straight and taper work can be turned, and that they are automatically returned to the starting point after reaching the end of the cut, thus relieving the operator of any movements other than those required in loading and unloading the work and starting and stopping the machine. The carriages are equipped with chip shields for the cross-feed screw, and the bed is covered the entire length, thus protecting the working parts of the lathe from dirt and chips. The chain that transmits the drive from the motor to the clutch shaft is also covered when the machine is in operation.

The tailstocks may be set to give a maximum center distance of 32 inches. The spindle of one of the tailstocks is operated by a screw, while the other is designed for a quick movement which is obtained by means of the foot-treadle.

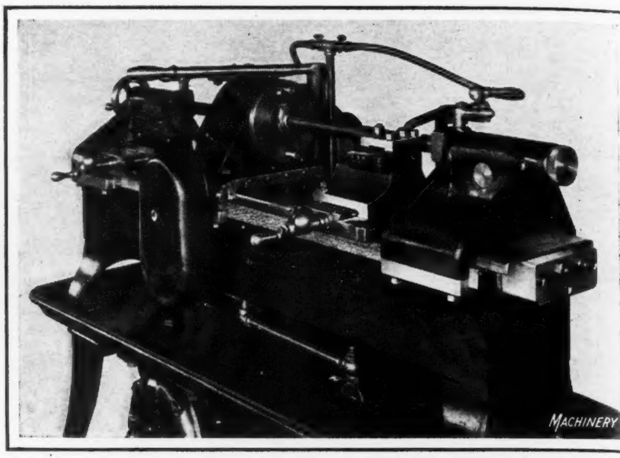


Fig. 2. Front View of the Center-drive Lathe

The bed is of the heavy box type and is solidly ribbed, while all gears are made of steel and run in oil in their respective housings. The machine can also be furnished with a countershaft for driving by belt. Its weight is about 1500 pounds.

AMS GANG SLITTER

A number of improvements have been made in a gang slitter which is built by the Max Ams Machine Co., 101 Park Ave., New York City, for slitting large quantities of thin sheet metal into strips. This slitting machine was designed primarily for use in making cans, but it is also adapted for cutting stock for armatures, electric switch parts, etc. From Fig. 1 it will be seen that the machine has a heavy frame in which are supported two power-driven parallel shafts or arbors, on which is mounted a series of circular cutters. The cutters of one shaft slightly overlap those of the other so as to slit the metal.

The table may be equipped with a power stock-feeding device or "back gage" for bringing the stock up to the cutters, and a gage which is attached to the left-hand side of the table for locating and guiding one edge of the stock. This power-feed mechanism and gage are not seen in Fig. 1, a hand feed being substituted in the machine shown in this view. With a hand-fed back gage, the stock is gripped at one place by this gage and at two places by the "disappearing" gage at the right-hand side of the table. After the cut has been started on the metal, the side gage releases its

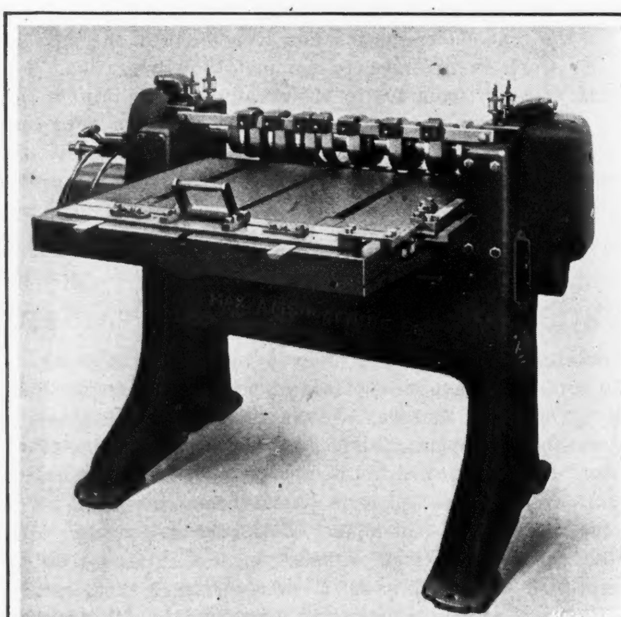


Fig. 1. Ams Improved Gang Slitter for Light Metal

hold and swings out of the way to permit the back gage to pass. This arrangement is especially useful in slitting decorated or lithographed metal. An attachment may be provided for grinding the cutters, power being transmitted from the machine to an overhead shaft which, in turn, drives a grinding wheel mounted parallel to the cutter shafts. Cutters may be ground without removing them from the machine or disturbing them from their relative positions.

One of the improvements in this machine is that the cutter shafts have been enlarged to 3 inches in diameter, and are ground and lapped to fit the hole in the cutters. The shafts run in bronze bearings, held by caps in housings that are integral with the frame. The split of the bearings is vertical to eliminate shaft play, the thrust of the shaft being at right angles to the screws that secure the caps in position.

Another feature of the cutter shafts is that no shoulder on them is larger than the diameter on which the cutters are mounted, and consequently the cutters can be removed from either end. A third new feature, for which patents are pending, is the method of securing the cutters on the shaft. This method is illustrated in Fig. 2, from which it will be seen that in a recess in the hub of each cutter are mounted two segmental pieces between which there is interposed a wedge-shaped piece that may be moved in or out by means of a screw in a tapped hole in the hub. By advancing this screw, the wedge-shaped piece is forced between the segmental pieces and wedges them between the cutter

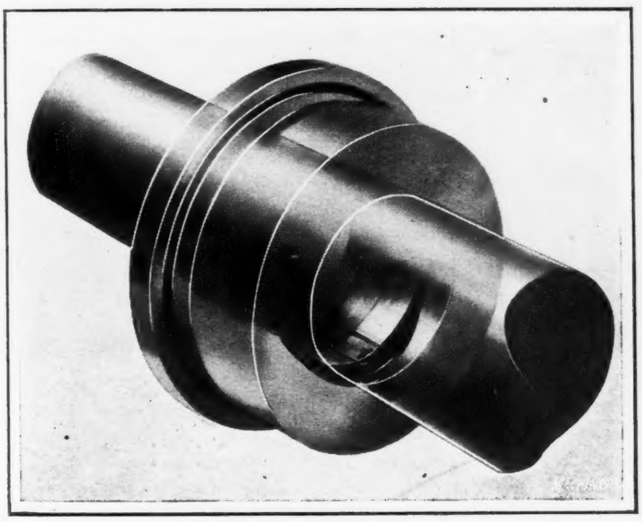


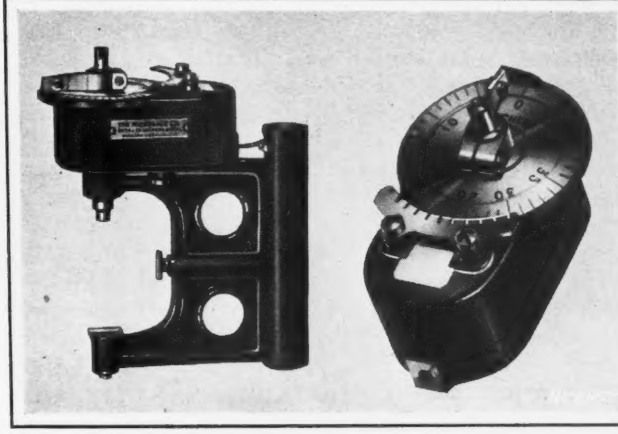
Fig. 2. Phantom View, illustrating the Method of locking the Cutters on the Arbors

hub and the shaft, thus locking the cutter firmly in position. The cutter is not thrown out of alignment by this method of locking, since there is no play between it and the shaft, because of the lapped fit.

MICROGAGE

The "Microgage" is a measuring or gaging instrument in which are combined the functions of both the micrometer and the limit snap gage. Variations from the nominal size of a part are indicated by a dial, graduated in thousandths of an inch, the variation being indicated both in amount and direction. This instrument is manufactured by the Microgage Co., Box 1126, Boston, Mass., and is shown in the accompanying illustration.

When the device is placed on a piece of work, the center plunger is automatically displaced, releasing a retaining brake from a spindle drum, and allowing a spring coiled inside the drum to screw the spindle on the work at a definite pressure. The operator then tries to shift the instrument sidewise so as to give it an opportunity to square itself or to show positively if it has already done so. When the microgage is withdrawn from the work, the retaining



Microgage Automatic Measuring or Gaging Instrument

brake is automatically applied before the gaging surfaces of the instrument have changed their setting. The position of a scribed line on the right-angled pointer relative to the dial graduations is thus positively retained until the microgage is used again. This process is repeated for each successive machining in finishing the work within specified limits, and when a new piece is started, the microgage is turned back by hand to make its contact points clear the piece. A measurement may be made in less than two seconds by the use of one hand, the other hand being free to start and stop the machine on which the part is machined.

The microgage is set for a particular line of work, by means of standards in the same way that it is applied to the work, at the same pressure and at the same position on the gaging surfaces. As the instrument is withdrawn from the standards, the retaining brake holds the spindle until the index-arm is set and clamped to the zero graduation. This fine adjustment takes less than one-half minute and is positive. The standards used may be basic-size plug gages, size-blocks, or reference disks. A tolerance segment facilitates setting the instrument.

Readings are taken quickly with the instrument held loosely in one hand. The frame is deep, the throat shallow, the radiating surfaces large, and the grip insulated on the larger sizes, all of which tends to reduce variations due to temperature. No skill or training is required for making the adjustment or using the instrument on work. The microgage is made in sizes to cover the complete range of from 1 to 5 inches, inclusive, the range of each instrument being ½ inch. It opens an additional 0.1 inch beyond its size to receive unfinished work.

HEXAGON MILLING TOOL

A milling tool for finishing the six sides of a hexagon in one operation has been brought out by the Geometric Milling Tool Co., 108-120 N. Jefferson St., Chicago, Ill. This tool, which is shown in the accompanying illustrations, was

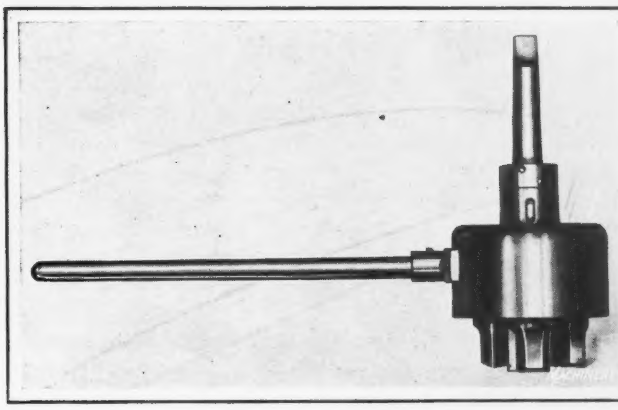


Fig. 1. Hexagon Milling Tool

designed primarily for use in valve manufacture, but it is also adaptable to producing locomotive nuts, oil-cups, etc. The six sides of a hexagonal part are produced by the planetary motion of three cutters, each of which has two cutting edges. These cutters revolve on their own axis and also about the center of the tool, thus generating a cycloid curve, as shown by the cutter diagram in Fig. 2. It will be obvious that the sides of the hexagon are curved, but this is so slight that it is not objectionable in most cases.

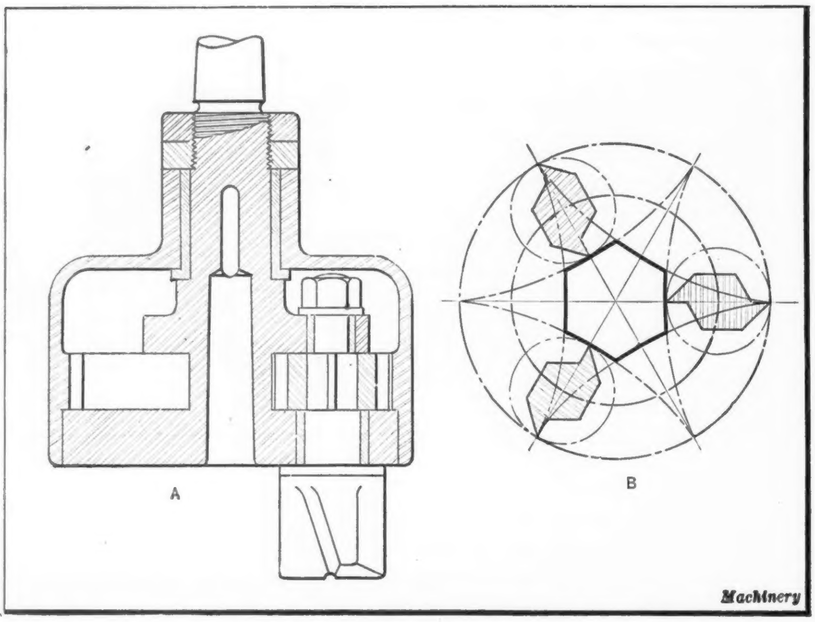


Fig. 2. Sectional View of the Hexagon Milling Tool and Lay-out of the Cutters

The tool can be employed in an ordinary drilling machine in conjunction with a simple fixture for holding the product and for guiding the casing or body of the tool. The body must be held from rotating by means of an arm gib, or pilot pin, but should be permitted to move up and down. In first setting up, the tool is indexed to conform with the outline or the center line of the hexagon to be milled, after which it remains permanently fixed. The cutters are interchangeable and easily sharpened and replaced. It is said that their wear is slow and that they do not leave any burrs on the corners of the hexagon or elsewhere. The tool is bronze-bushed throughout, and made in standard pipe sizes of 3/8, 1/2, 3/4, 1 and 1 1/2 inches. This tool may also be used for drilling and facing, and in an operation on standard 3/4-inch valve bodies it has drilled, faced, and milled the body in about fifteen seconds, the tool running at 180 revolutions per minute.

GRAY "MAXIMUM-SERVICE" PLANERS

Planers of the "Maximum-Service" type built by the G. A. Gray Co., Gest and Depot Sts., Cincinnati, Ohio, are now built in 60- and 72-inch sizes. In general design these machines, which are the largest this company has ever built, closely follow the planers of smaller sizes described in MACHINERY, December, 1921. The grouping of controls on the operator's side of the machine considerably facilitates the operation. To raise the rail, the operator pushes up the stirrup at his end of the rail, which gives him a control of the movement without leaving a position from which he can observe the work and tools. The rail stops without drifting, and so it can be set to a line. It is clamped by a few turns of the clamping screw at the right-hand end of the rail. This results in locking both ends of the rail to the inside edge of each housing and ties the entire structure firmly together. Having located the rail, the operator can move a head into position by simply shifting one lever, and the slides may be rapidly raised or lowered by manipulating the middle traverse lever which is also at the right-hand end of the rail. The feed dial of the "Cantslip" feed is locked in place until the operator's hand touches the knob, when it can instantly be set to any desired feed between 0 and 1 inch in steps of 0.01 inch.

Oiling of the planer has been carefully considered: The gears, which are helical throughout, run in a bath of oil, and from the oil-pan under the gears oil is taken through a strainer and pumped through a filter to each of the shaft bearings and to the center of each vee. The corner of the table vee is cut away almost to the ends of the table, and into the space thus formed the filtered oil is pumped through a hole. This channel is always closed at each end, and from it small oil-grooves conduct lubricant over the vee surfaces. Since the oil in the grooves is all under the same pressure, an even distribution is insured.

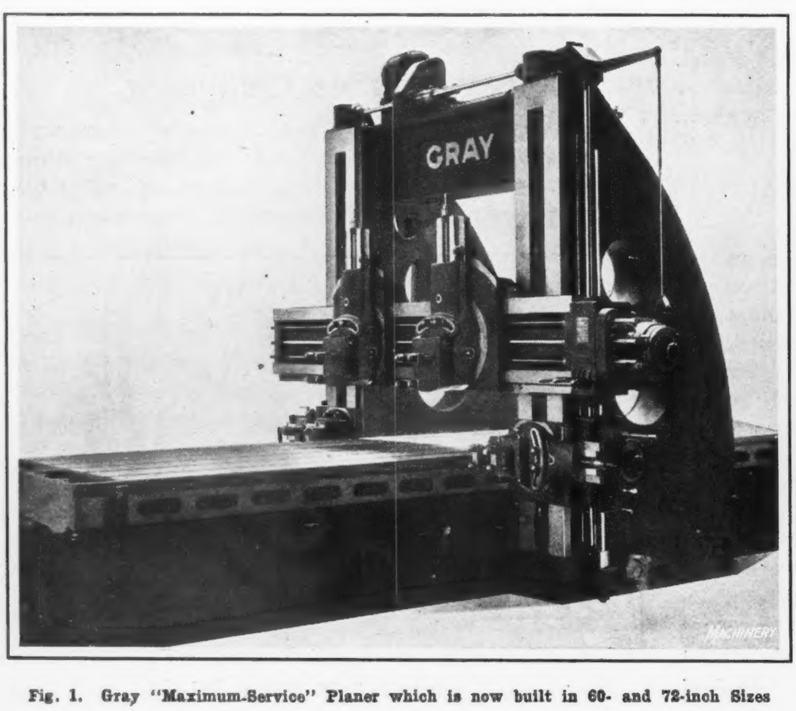


Fig. 1. Gray "Maximum-Service" Planer which is now built in 60- and 72-inch Sizes

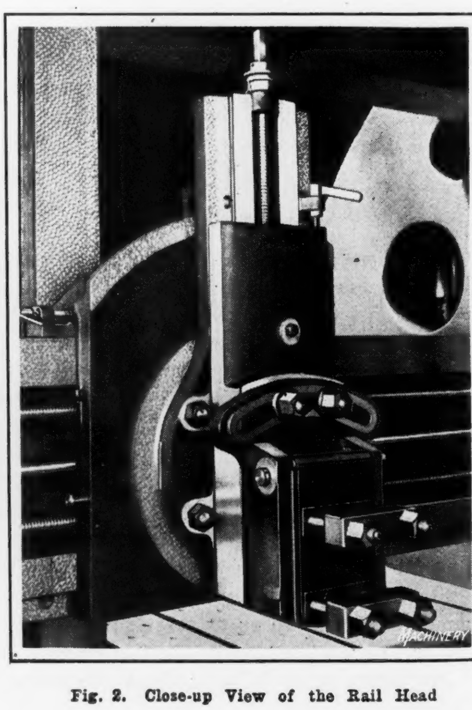


Fig. 2. Close-up View of the Rail Head

A close-up view of the new type of rail-head supplied on these planers is shown in Fig. 2, from which it will be seen that "twin-purpose" gibs are provided between the slide and harp. A turn of the gib handle in one direction adjusts the gib to the operating position, while a turn in the opposite direction results in rigidly locking the slide to the harp. Similar gibs are provided between the saddle and the rail. There is also a clamp for locking the harp to the top of the saddle.

NEWTON PLANER-TYPE MILLING MACHINES

A new series of planer-type milling machines has been added to the line of heavy-duty milling machines known as the "Multi-Millers" which are built by the Newton Machine Tool Plant of the Consolidated Machine Tool Corporation of America, 17 E. 42nd St., New York City. The machines are provided with a wide range of feeds and table speeds to adapt them for both light- and heavy-duty milling. Control levers are located on both sides of the machine in front of the housings, so that the operator may have complete control from the side that may happen to be the most convenient. The bed is of one-piece box construction, with a closed top, and has an internal gib which clamps the table to the bed when the vertical heads are fed along the cross-rail. The table is of double-plate construction, and when the machine is equipped with a cutter lubrication system, the table is fitted with shields and arranged to handle the lubricant in large volume.

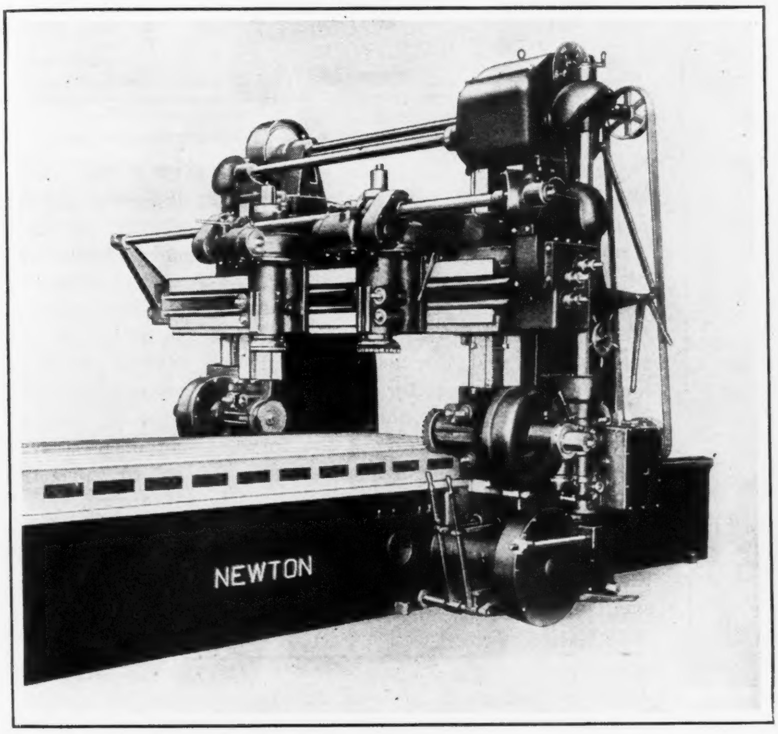


Fig. 1. Newton Planer-type Milling Machine with Four Heads

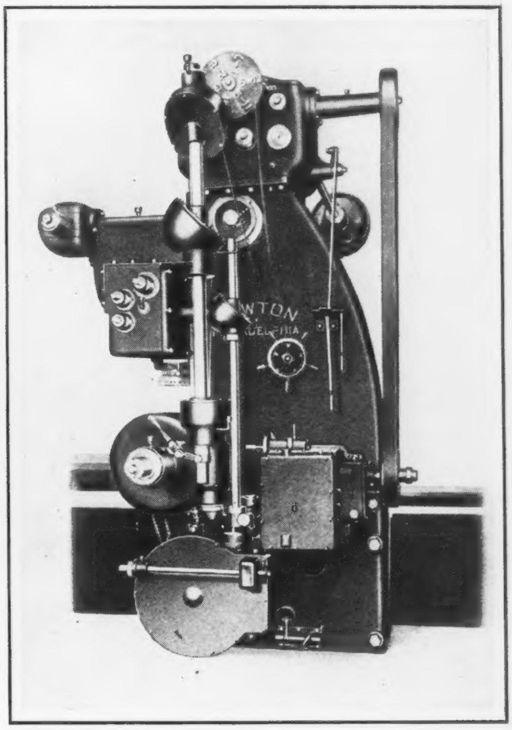


Fig. 2. View of the Right-hand Housing

Power rapid traverse is provided to move the table at the rate of 12 feet per minute in both directions, and there is also a hand adjustment. The table length is sufficient to allow a 12-inch cutter to clear the work at both ends when the table has traveled a distance equal to the rated length of the machine. There are eighteen table feeds ranging from 1 to 33 inches per minute which are obtained independently of the spindle speeds. The housings are reinforced at the top by a deep-section tie-beam. The cross-rail can be raised and lowered by means of a power rapid traverse in both directions, at the rate of 3 feet per minute, and there is a hand adjustment controlled from the crank at the end, the adjustment being 1/8 inch for each turn of the crank. The cross-rail is clamped to the inner and outer faces of both housings by cam-actuated clamps controlled from the front of the machine.

The head saddles on the cross-rail are independent of one another, even though the feed and rapid traverse are taken from the same shaft. Each saddle has a hand adjustment, feed and rapid traverse in both directions, and a means of clamping when a table feed is being used. The feed of each head is engaged or disengaged from the end of the cross-rail, and ranges from 1/2 to 16 1/2 inches per minute. The saddles for the horizontal spindles are separately counterweighted, independently controlled, and so arranged that they can be bolted to the under side of the cross-rail when desired.

All head spindles are made from solid steel forgings, and have a Morse taper hole, face keyway, and a draw-in bolt. They run in bronze bearings and are fitted with double splines and take-up collars to compensate for wear. The quills have a 6-inch adjustment and may be fitted either with Ames dials or scales. On each head there is provision for disengaging the spindle so that it does not operate except when required. The machine can be arranged for either a belt or motor drive through a friction-clutch pulley mounted on top of the left-hand upright, the power being transmitted through a horizontal shaft to a twelve-speed gear-box on the right-hand upright. The motor can be mounted on the floor, wall, or ceiling, as preferred, and belted to the main pulley.

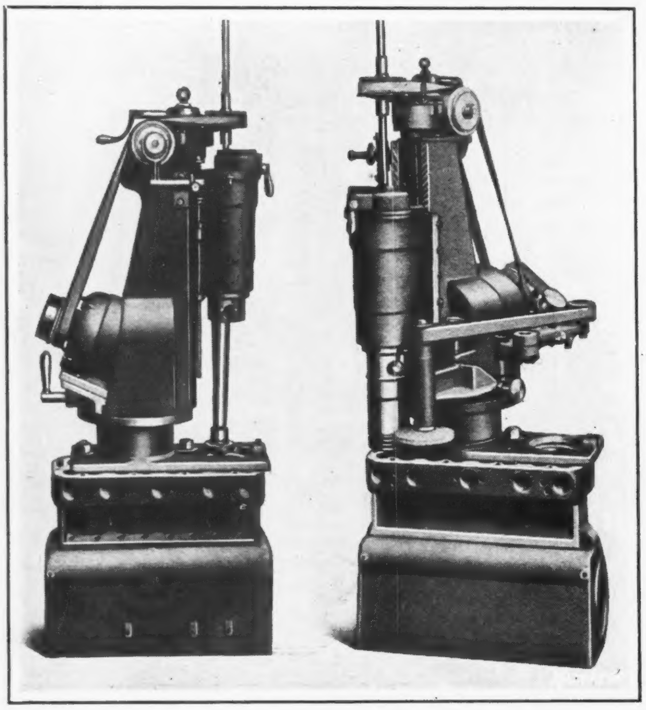
GISHOLT "DU-ALL" CYLINDER AND PISTON GRINDER

Both automobile cylinder bores and pistons can be reground by means of a portable equipment that has been developed by the Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. This "Du-All" grinder may be clamped directly on the cylinder block, as shown at the left in the accompanying illustration, or to a bench for grinding single or double cylinders. The wheel-spindle is mounted in a vertical slide, which is fed up and down, either automatically or by hand, to traverse the wheel along the bore. The eccentricity of the grinding wheel in revolving is regulated to suit the particular bore by operating a graduated worm dial. Power for rotating the wheel-spindle and for feeding the slide is obtained from a motor mounted on the machine,

which may be supplied for either direct or alternating current taken from an ordinary lighting circuit.

A unique self-aligning fixture is provided for accurately locating the wheel-spindle relative to a cylinder bore before grinding. This fixture has a flange which fits snugly into a hole in the base of the machine near the front, and it also has three balls which are expanded radially from the center of the fixture when it is in place in the base, so that they will contact with the wall of the bore. This results in the machine being swiveled into the proper position, and permits locking in correct alignment with the cylinder bore. Grinding is performed on both the up and down strokes. There is a suction blower on the right-hand side of the machine for carrying away the grinding dust. The wheel-slide has a travel of 14 inches. The length and range of the slide movements are controlled by means of a tripping mechanism which operates friction clutches and pulleys on top of the machine.

In grinding pistons, the vertical slide is provided with a special adapter for holding the work, as shown at the right in the illustration, and a grinding wheel is mounted



Gisholt Equipment for regrinding Both Cylinder Bores and Pistons

on the shaft that drives the exhaust blower in cylinder grinding. The piston is fed up and down past the wheel. There is an adjustment to regulate the grinding depth, and adjustments for regulating the tension on all belts.

"MACALENE"

A mixture known as "Macalene," which is added to quenching water or oil to harden and toughen iron castings, is made by the McCadden Laboratories, St. Cloud, Minn. Hardening by this method is recommended by the maker for automobile pistons and cylinder blocks; forming and bending dies; clutch plates; machine tool parts such as cams, turrets, and tailstock castings; locomotive valves; brake-shoes; and other parts. The preparation is mixed with ordinary pure water in the ratio of one gallon to fifty gallons of water. The work is heated to a temperature of about 1440 degrees F. and quenched in the solution, after which it is drawn to a blue color, in most instances. In this condition the work is said to be from 25 to 50 per cent stronger than ordinary cast iron. An automobile piston tested by the Brinell process had a hardness of 450 as compared with 223 of a soft untreated piston. "Macalene" has no effect on steel.

KINGSBURY AUTOMATIC SENSITIVE DRILLING MACHINES

A description of an automatic sensitive drilling head made by the Kingsbury Mfg. Co., Keene, N. H., was published in November, 1922, MACHINERY, and an application of

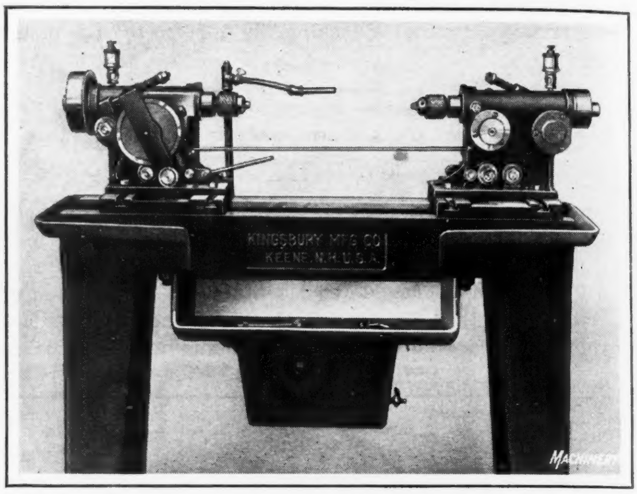


Fig. 1. Kingsbury Automatic Sensitive Drilling Machine with Opposed Heads

this head on a machine equipped with an indexing dial for cross-drilling rivets appeared in the March, 1923, number. The accompanying illustrations show two more applications of this head. Fig. 1 shows a machine equipped with two heads for simultaneously drilling two holes from opposite sides, or for drilling and reaming through holes. In the set-up illustrated, the head at the left is used for drilling, and that at the right for reaming. After clamping the work in a fixture, the operator presses the trip-lever at the left, and when the drill reaches the forward end of its travel, the opposing spindle is automatically tripped to cause the reamer to enter the work as the drill is withdrawn.

In Fig. 2 is illustrated a machine equipped with four heads, the spindles of which are located at right angles to the length of the table. This machine is intended for small single-hole drilling. The countershaft is mounted on

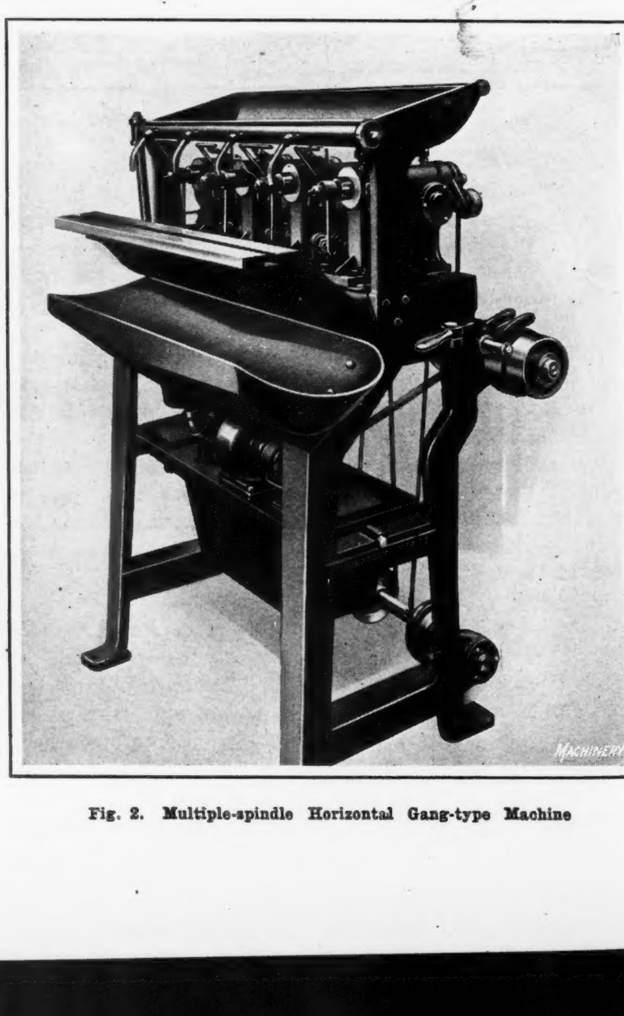


Fig. 2. Multiple-spindle Horizontal Gang-type Machine

SKF ball bearings, and gives three spindle speeds of 4000, 3200, and 2500 revolutions per minute; however, a single-speed countershaft may be furnished if desired. The machine is also built with two or three heads. The weight of a four-head machine with the spindles spaced 8 inches apart is approximately 800 pounds.

TUBE SHEAR

A machine for cutting off pipe and tubing, which operates on a new principle, has been developed by the Tube Shear Co., Marquette Bldg., 140 S. Dearborn St., Chicago, Ill. In this machine the tubing is sheared over an arbor with a non-rotating ring shearing knife, and this method is successfully applied to steel, brass, and aluminum, with particular efficiency on the thinner wall sizes. One of the advantages that are claimed for this construction is that it is unnecessary to chuck or clamp the tubing, as neither the ring shear knife nor the tubing rotates. A further advantage is that the load-sustaining shear blocks bear directly in the plane of shear, regardless of the tube length. The arbor knife is supported through the tubing directly in the plane of shearing, and so the casting to which the arbor knife is attached receives none of the shearing load, its purpose being merely to align the shear knife.

The head of the machine is driven from an overhead motor, and is rotated once to cut off a piece of tubing. The machine is of the back-geared type, operated by means of a foot-treadle and a positive clutch mechanism. It has a fixed stroke which, contrary to the common conception that a shear stroke is governed by the shearing angle of the knife, is governed by the maximum wall thickness of the tubing for which the machine is designed. It is said that, regardless of the size of the shearing machine, the fixed stroke need in no case be greater than the maximum wall thickness, as it is not considered necessary on any class of stock for the knife to pass completely through the wall of the tube.

The shearing angle is established by the difference in diameter between the ring knife and the outside diameter of the tube, and is controlled by the main knife adjustment

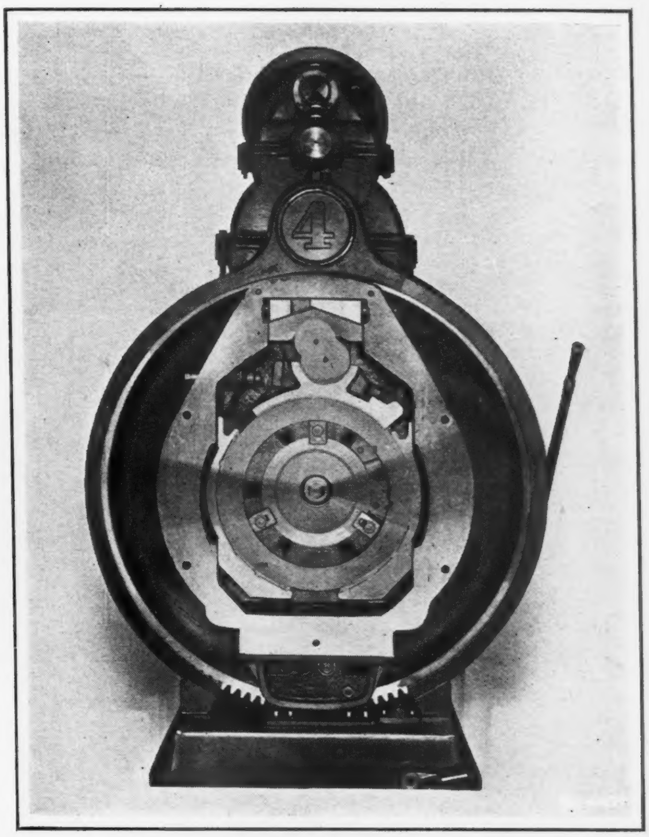


Fig. 2. Front View of the Tube Shear with the Cover Plate removed

and not by the stroke. This adjustment is located on the shear head directly in line with the stroke-actuating member, and governs the eccentricity in which the ring shear block operates. This eccentricity is fixed by the shearing angle, or the difference in diameter between the ring knife and the outside of the tube.

An adjustment for knife alignment is made from the front of the machine, the arbor being detachable without affecting this alignment. Any flexibility of the arbor due to its length is compensated for by supports which position themselves automatically as the tube is fed out. The tube travels on rolls which are adjustable to suit various diameters. The stop and feed mechanisms are also adjustable for shearing to different lengths and for feeding different diameters. A feature of the machine is the accessibility of the ring and arbor knives, which are plain, hardened rings.

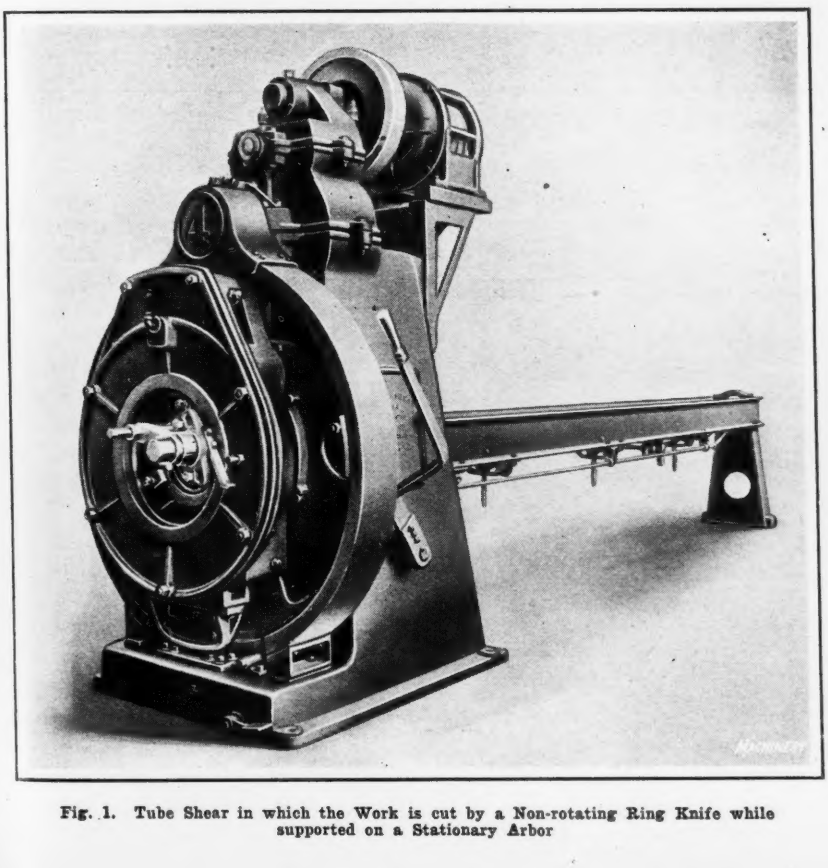
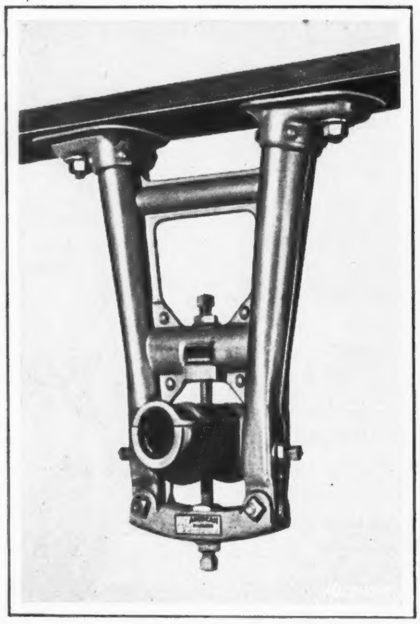


Fig. 1. Tube Shear in which the Work is cut by a Non-rotating Ring Knife while supported on a Stationary Arbor

AMERICAN PRESSED-STEEL SHAFTING HANGER

A pressed-steel shafting hanger of the four-point set-screw type is being introduced to the trade by the American Pulley Co., Philadelphia, Pa. This hanger is of the "parting" variety; that is, it has a swing yoke which readily permits the removal of the shaft or bearing. The main frame of the hanger is constructed of two stampings, placed face to face with in-turned flanges extending the entire length of the legs. The flanges are said to provide unusual strength and rigidity. The cross-brace is integral with the legs. All bolts, nuts, and set-screws are standard and accessible, so that replacements may be conveniently made. The foot of the hanger is made of heavy cold-drawn seamless metal, and is ample to sustain the pressure of the clamping bolts or lag screws.

It is attached to the oval frame leg by means of rivets. The frame is smooth, with rounded surfaces that eliminate dust pockets and projecting parts. This hanger is made in the regular drop sizes from 7 to 24 inches and for all shafting up to 3 inches. The bearing box is babbitted and the bearing is broached to size.



American Pressed-steel Shafting Hanger

MUELLER GEARED-HEAD LATHE

The 18-inch geared-head engine lathe shown in Fig. 1 is built by the Mueller Machine Tool Co., of Cincinnati, Ohio. On this machine there is an apron control of sixteen spindle speeds, and the forward and reverse movements of the spindle are also controlled from the apron. All speed changes are made without stopping the driving pulley. The long vertical lever at the front of the head controls four changes of speed from the main driving shaft through patented friction clutches, only one of which can be operated at a time. These four speed changes are transmitted direct to the spindle with the back-gear pinion withdrawn from the spindle gear and with the sliding clutch collar on the spindle engaged.

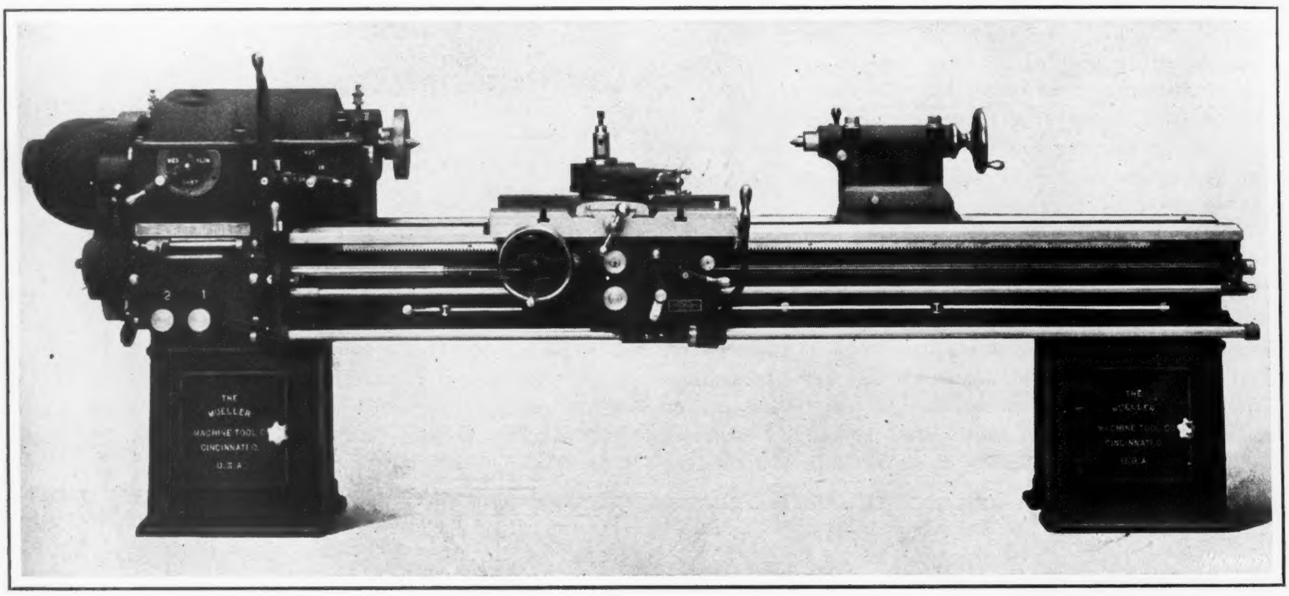


Fig. 1. Mueller Geared-head Engine Lathe

The small lever on the headstock to the right of the vertical lever alternately operates both the spindle clutch and the back-gear pinion, and the lever to the left controls a double- and a single-jaw clutch on the back-gear shaft in such a way that only one of these clutches can be engaged at a time. The engagement is made through spring pressure, and so the operating lever can be placed where required, even though the clutch jaws are not in mesh. The action is positive in disengaging any of the jaw clutches. By multiplying the triple back-gear speeds with those of the first driving shaft, twelve speeds are obtained in addition to the four secured without the back-gear, making sixteen speeds in all. The three gears and clutch on the spindle are on one quill and revolve on the spindle. All keys are milled integral with the shafts, and all bearings are bronze-bushed and self-oiling. The jaw clutches are made of nickel steel and hardened, and the gears are of stub tooth form.

The reversing mechanism is a separate unit which is bolted to the head, and it supports the first driving shaft in two radial ball bearings. The driving pulley has an internal gear on the left side and a friction clutch on the right, the latter being engaged for imparting a right-hand motion to the first driving shaft. For a left-hand drive, a pinion is engaged with the internal gear of the pulley to deliver power across to a friction gear and give this gear a reverse motion to that of the pulley. A sliding collar controls the two friction clutches, the collar being operated by means of a fork, as shown in Fig. 2, and a lever below the attachment. This lever is connected under the lathe head to the levers on the lower splined shaft on the front of the bed. By this arrangement the lever mounted at the right end of the apron has full control of starting, stopping and reversing the lathe spindle. Adjustable dogs are attached on a flat bar at the front of the bed to trip the automatic feed at any desired point. This machine may also be arranged for motor drive; when so arranged, the motor is bolted to the rear of the cabinet leg beneath the headstock of the machine.

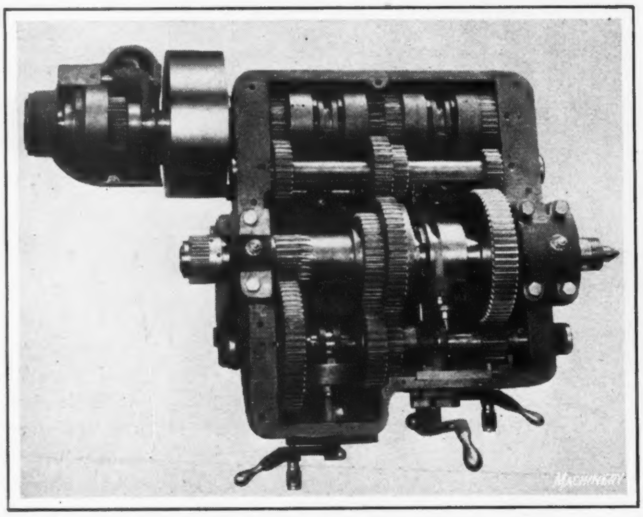


Fig. 2. View of the Geared-head Mechanism

ROLLER-BEARING LOOSE PULLEY AND COUNTERSHAFT BOX

Loose pulleys from 2½ to 22 inches in diameter, equipped with adjustable taper roller bearings for taking end thrust, as shown in Fig. 1, are manufactured by the St. Louis Machine Tool Co., 932 Loughborough Ave., St. Louis, Mo.

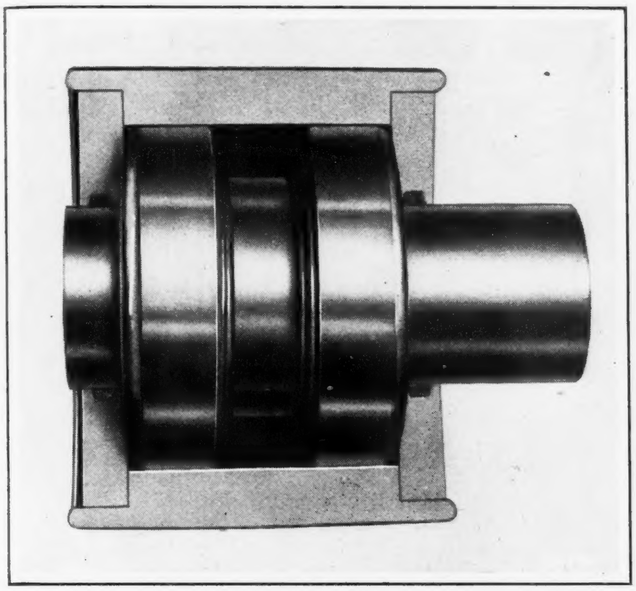


Fig. 1. St. Louis Loose Pulley equipped with Taper Roller Bearings

When the pulleys are small in diameter, as on polishing machines and many other types of high-speed equipment, the bearings are mounted directly on a shaft, but it is preferable to mount them on a sleeve. An advantage of the sleeve installation is that the pulley can frequently be mounted on worn shafts and arbors.

Roller bearings of the same type are also being supplied in the countershaft box that is shown in Fig. 2 in place in a hanger. The box has sockets to provide for adjustment of its position by means of set-screws. The back of the box is solid, while on the front there is an end plate. A felt groove and retainer is provided at both the front and back. The box can be furnished with or without the pressed-steel hanger shown.

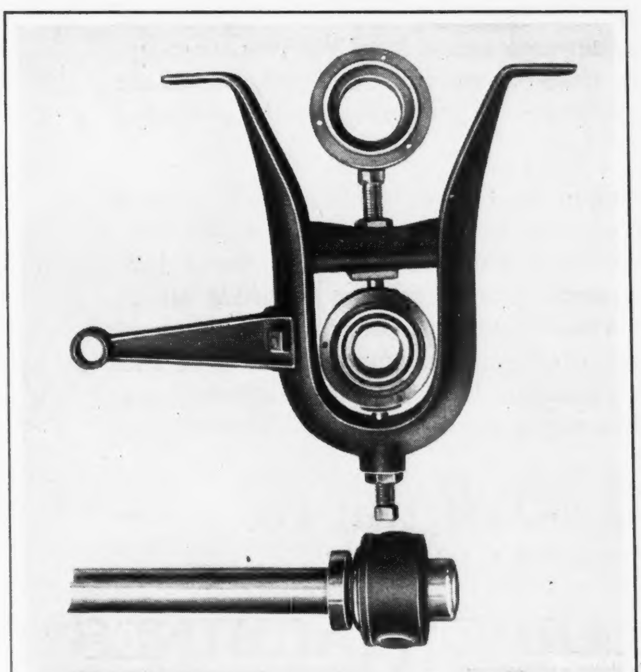
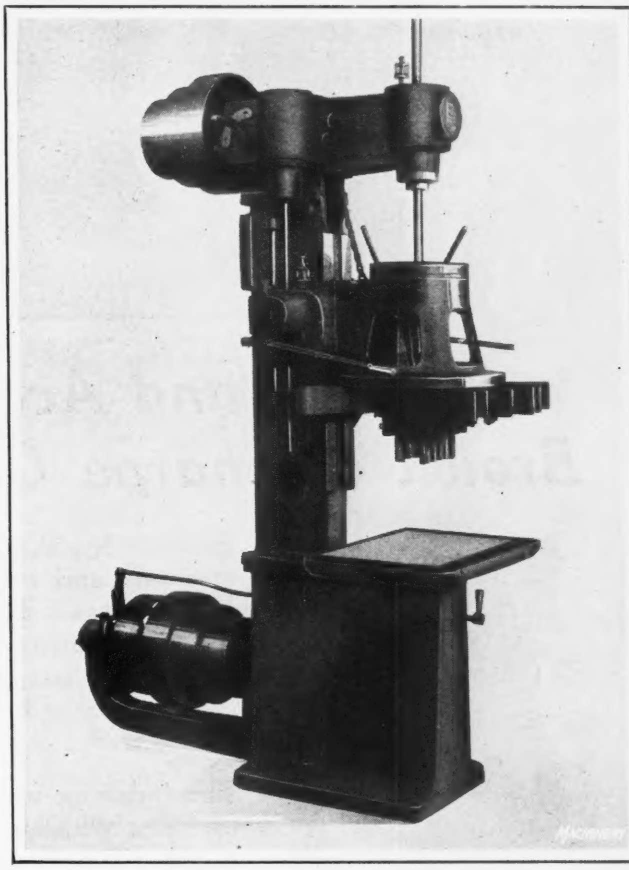


Fig. 2. Roller-bearing Countershaft Box and Pressed-steel Hanger

FOX MULTIPLE-SPINDLE DRILLING MACHINE

A cone-pulley-driven multiple-spindle drilling machine designated as the No. 12-A is being introduced to the trade by the Fox Machine Co., Jackson, Mich. The lower cone is mounted on a countershaft which runs in Hyatt bearings and is driven by an Edgemont clutch controlled from the front of the machine, and the upper cone is mounted on a 1⅜-inch shaft which runs in S. R. B. ball bearings. The cone pulleys are intended for a 4-inch belt. The yoke that supports the upper driving pulley also contains the feed gearing. Three changes of feed are obtained by means of sliding cone gears which transmit power through a worm and worm-gear to the vertical feed shaft. The worm and worm-gear are always in mesh, and they are submerged in oil, while the feed gearing also dips in oil. A clutch for engaging and disengaging the feed is operated by means of the lever at the left. The pilot wheel on the right-hand side of the machine is rotated to raise and lower the head through a rack and pinion mechanism.

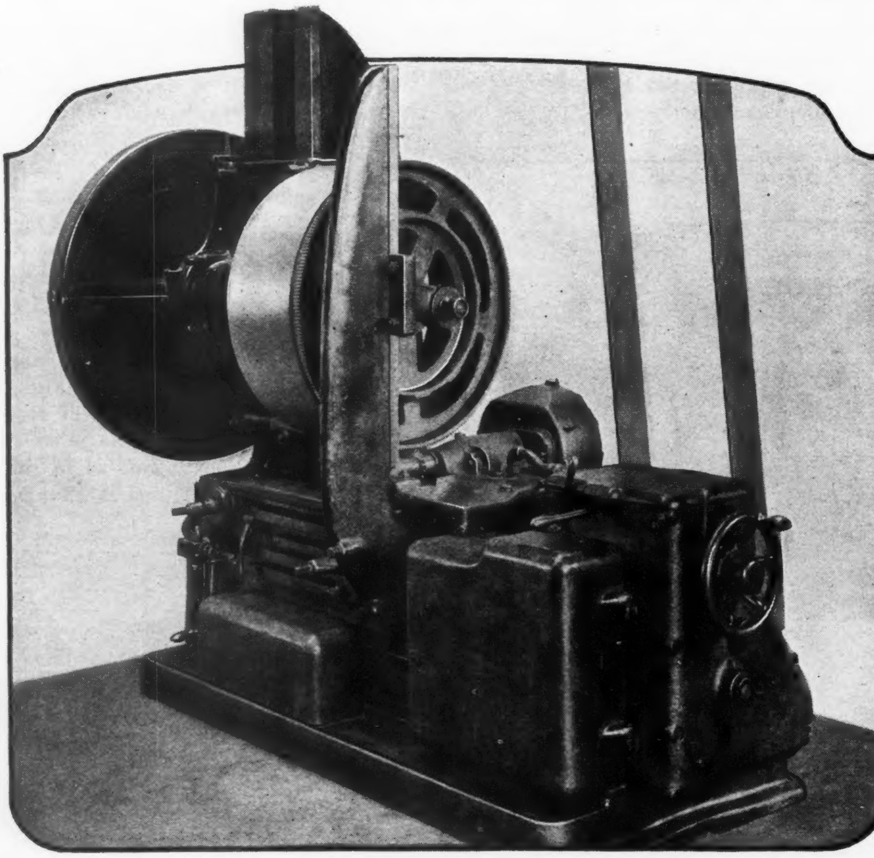


Fox Multiple-spindle Drilling Machine

Power is transmitted to the vertical driving shaft through bevel gears at the front of the yoke which are mounted in ball bearings. A round head accommodating twelve spindles, ⅞ inch in diameter, which may be located at any point within a 12-inch circle is furnished on the machine. The head is counterbalanced by a weight in the column, and the spindles have a vertical adjustment in their holding arms. This machine is designed especially for using small high-speed drills, and it has a capacity of 10 horsepower. A motor may be mounted on a special bracket in place of the lower cone pulley when a motor drive is preferred. The weight of this machine is about 3070 pounds.

* * *

In 1869 the value of the manufactured products of the United States was slightly over $1,000,000,000. In 1919 it was $62,418,000,000. The power used in 1869 was 2,350,000 horsepower. Fifty years later, in 1919, it was 30,000,000 horsepower.



Strength and Accuracy—Features of Brown & Sharpe Gear Cutting Machines

Our catalog listing a complete line of mechanical equipment is a valuable source of information for mechanics, foremen or shop superintendents. Six hundred pages — yet small enough to fit the pocket. Ask for No. 137.

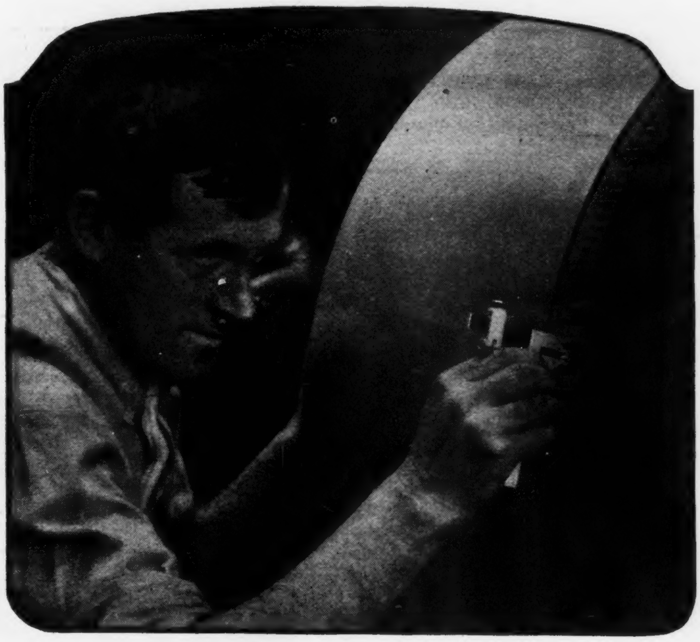
Brown & Sharpe Gear Cutting Machines have the strength and precision essential for accurate work on heavy gears. The sturdy upright and arbor support and the long bearing for the work arbor hold the work rigidly. Accurate spacing is assured by an extremely accurate index wheel of large diameter in proportion to the diameter of the work.

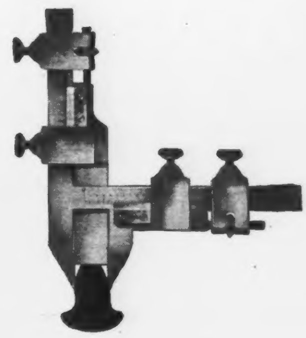
The indexing mechanism on Brown & Sharpe Machines operates without shock—an important feature when cutting big gears. In Brown & Sharpe Machines, the indexing cycle begins and ends gradually—the wearing effect of sudden jars is eliminated—the accuracy of the indexing mechanism is preserved—and accurate spacing of the teeth on large gears is insured. Consider these advantages of Brown & Sharpe Machines in connection with your own gear cutting.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

Use BROWN & SHARPE MACHINES *for Production*



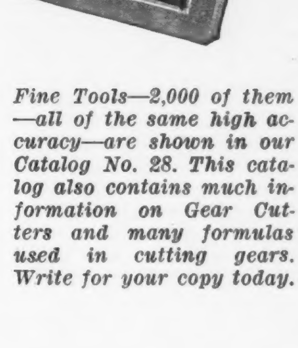


Gear Tooth Vernier No. 580 measures thickness of gear teeth at pitch line or chordal thickness and distance from top of tooth to the chord. Provide your gear men with this accurate tool.

Gear Makers Need the Help of Brown & Sharpe Tools

Proper tools play an important part in making accurate gears. Every step from turning the blank to testing the finished gear needs the help of Brown & Sharpe Tools. Use Vernier Caliper No. 573 for measuring the blank and the bottom diameter of gears. Gear Tooth Micrometer No. 249 is handy for scribing blanks to show extreme depth of teeth. In setting up large gears a Dial Test Indicator is essential.

Gear Tooth Vernier No. 580, shown above, is valuable for accurately measuring the size of teeth when starting to cut a blank. Supply your men with these Brown & Sharpe Tools —gears of more uniform accuracy will be the result.



Fine Tools—2,000 of them —all of the same high accuracy—are shown in our Catalog No. 28. This catalog also contains much information on Gear Cutters and many formulas used in cutting gears. Write for your copy today.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

BROWN & SHARPE TOOLS

for Accurate Work

PERSONALS

STANLEY P. SEWARD has been appointed advertising manager of the White Co., Cleveland, Ohio, succeeding M. H. Newton.

THAD DEAN WHEELER, formerly of the McGraw-Hill Co., has been appointed vice-president of the Sweet & Phelps Advertising Agency, 210 E. Ohio St., Chicago, Ill.

ALEXANDER T. GALBRAITH, formerly general manager of the Halcomb Steel Co., Syracuse, N. Y., has been made general manager of sales of the Crucible Steel Co. of America, Syracuse.

L. M. DALTON has succeeded E. J. Burnell as manager of the Boston Branch office of the Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Mr. Burnell resigned his post to enter business for himself.

F. H. WORTHINGTON, associated with the Jacksonville, Fla., office of the General Electric Co., has been appointed local manager of the Jacksonville office to succeed G. C. Henry who recently resigned.

HOWARD W. GILLETTE, who has been connected for several years with the Ogden R. Adams Co., Inc., Rochester, N. Y., has been transferred to the Syracuse office of the company, of which he will be in charge.

FRED R. LOW, of New York City, editor of *Power*, was nominated for the presidency of the American Society of Mechanical Engineers for the year 1924, at the spring meeting of the society held in Montreal, Canada.

C. F. ROGERS, who formerly represented C. E. Johansson, Inc., in the eastern territory, has been appointed factory representative for the W. B. Knight Machinery Co., of St. Louis, Mo., manufacturer of milling and drilling machines.

H. R. SARGENT, formerly manager of the wiring supplies division of the Bridgeport Works of the General Electric Co., has been appointed managing engineer of this division under a development plan that will create several unit divisions at the Bridgeport factory.

CHARLES P. HERY, who has had many years' experience in the sale of metal- and wood-working machinery, mill supplies, and small tools, has become associated with the Ogden R. Adams Co., Inc., Rochester, N. Y., and will be located at the main office of the company.

George A. Stetson, assistant professor of mechanical engineering at Yale University, and for the last four years editor of the transactions of the American Society of Mechanical Engineers, has resigned both these positions to enter the wholesale coal business in Boston.

W. R. WHITNEY, director of the Research Laboratory of the General Electric Co., Schenectady, N. Y., was recently elected a member of the corporation of the Massachusetts Institute of Technology for a term of five years. He was graduated from the institute in 1890, and has for some time been a non-resident professor of theoretical chemistry there.

W. H. TOWNSEND, formerly factory manager of the Automobile Screw Products Co., Cleveland, Ohio, and prior to that time connected with the Atlas Bolt & Screw Co., also of Cleveland, has become affiliated with the Cleveland Duplex Machinery Co., Inc., 1224 W. 6th St., Cleveland, as sales engineer, specializing in semi-automatic and automatic machinery.

LEWIS S. EDGARTON, professor of metallurgy at the Mechanics Institute, Rochester, N. Y., has become associated with the Ogden R. Adams Co., Inc., of Rochester, and will be connected with the Buffalo office of the company. Mr. Edgarton is a graduate of the Massachusetts Institute of Technology and a member of the American Society of Mechanical Engineers.

FRANKLIN S. TERRY, co-manager of the National Lamp Works, Neal Park, Cleveland, Ohio, was elected vice-president of the General Electric Co., Schenectady, N. Y., and B. G. TREMAINE, also co-manager of the National Lamp Works, was elected a director of the company, at a meeting of the board of directors held in New York City, June 22. Both Mr. Terry and Mr. Tremaine have long been prominently identified with the electrical industry.

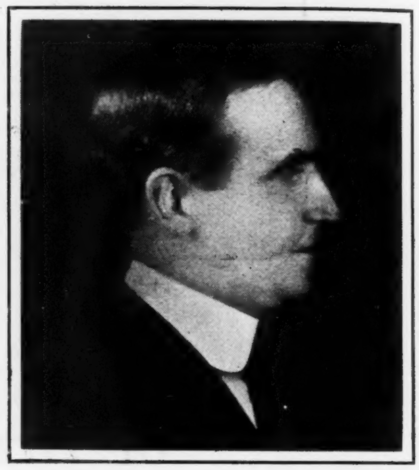
HENRY K. SPENCER has been appointed manager of the Blanchard Machine Co., 64 State St., Cambridge, Mass., manufacturer of high-power vertical surface grinders. Mr. Spencer's connection with the company dates from the beginning of its surface grinder business. Prior to the death of the late Winslow Blanchard, Mr. Spencer was assistant manager and chief engineer. The business will be continued by the same interests and along the same lines as heretofore.

GERARD SWOPE, president of the General Electric Co., Schenectady, N. Y., was awarded the honorary degree of Doctor of Science at Rutgers College on June 12. OWEN D. YOUNG, chairman of the board of directors, was given the degree of Doctor of Literature at St. Lawrence University, of which he is an alumnus, and DR. IRVING LANGMUIR, assistant director of the Research Laboratory, received the honorary degree of Doctor of Science from Union College, Schenectady. DAVID B. RUSHMORE, consulting engineer, was given the degree of Doctor of Science by his alma mater, Swarthmore College. All of these men have been greatly interested in furthering scientific education in our colleges and schools, and have taken a leading part in the forward-looking movement of cooperation between the colleges and industry.

OBITUARIES

CLYDE M. CARR

Clyde M. Carr, until recently president of Joseph T. Ryerson & Son, Inc., Chicago, Ill., died June 5 after an illness of several weeks. Mr. Carr retired as president last February on account of poor health, but continued to serve as a director until the time of his death. He was born in Illinois in 1869, and was educated at Princeton and Northwestern Universities. He first became associated with Joseph T. Ryerson & Son in 1890, and was elected president in 1911. Previous to his connection with the Ryerson Company, he had been associated with the People's Gas Light & Coke Co., and W. S. Mallory & Co. Mr. Carr had always been an active leader in civic and industrial circles, and his far-reaching influence accomplished much wherever he was interested. He was a member of the American Iron and Steel Institute.



WILLIARD T. SEARS research and experimental engineer of the Niles-Bement-Pond Co., New York City, died recently at Montclair, N. J. Mr. Sears had been with the company for over twenty years. Prior to this he was connected with the Pennsylvania Steel Co. for a number of years. He was a member of the class of 1887 of the Massachusetts Institute of Technology. Mr. Sears was an inventor of exceptional imagination and the machine tool industry has greatly benefited from the many developments which he originated.

INDUSTRIAL MACHINERY IN CHINA

It has long been believed, states W. H. Rastall, chief of the Industrial Machinery Division of the Department of Commerce, that the conditions in China are practically unchanging. Recent developments show, however, that the market for industrial machinery is rapidly increasing in that country, and that American products occupy an important position in the trade. In 1921 China imported over $41,000,000 worth of industrial machinery, as compared with about $5,000,000 in 1913, which was the highest importation up to that time. The United States furnished $16,000,000 worth of industrial machinery in 1921, as compared with about $500,000 worth in 1913. Expressed in percentages, the United States supplied less than 10 per cent in 1913, and nearly 40 per cent in 1921. Of the machine tools imported into China in 1921, the United States, the United Kingdom, and Japan supplied practically 30 per cent each. In textile machinery, the United States supplied 44 per cent; the United Kingdom, 42 per cent; and Japan nearly all the remainder.

* * *

Between 1916 and 1921 there was a decrease of 2200 miles in the length of railroad lines operated in the United States. In the period from 1910 to 1915 there was an increase in the operated mileage of 20,000 miles.

Rush! So They Machined This Die on the Cincinnati Miller

First, this nickel steel die block was needed in a hurry, second, the operator was a piece worker; two good reasons for putting it through on the Cincinnati Miller.

Two operations were performed; first, a roughing cut taken with a cutter 10" in diameter, then a shanking cut with a conical shanking cutter 3" in diameter. Time on the actual operation is not available but time for the change from one to the other is interesting.

Without moving from his position the operator lowered the table, ran it back to the starting end of the cut, engaged the cross feed for the proper distance, changed the tool and started the second cut in less than two minutes—which certainly cuts non-productive time to nearly the possible minimum.

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI, OHIO, U. S. A.

Operating conveniences that speed up production make Cincinnati Millers profitable. Let our service department show you records and give you details of production on work that is similar to your own.

Photographed at the Cleveland Hardware Company, Cleveland, Ohio

CINCINNATI MILLERS

TRADE NOTES

Skinner Chuck Co., New Britain, Conn., have opened a new branch office in Cincinnati, Ohio, at 915 Broadway.

Aetna Ball Bearing Mfg. Co. is now located at 2737 High St., Chicago, Ill., in new quarters which have greatly improved facilities for production and service.

Electric Steel Co., Chicago, Ill., has changed its name to Nugent Steel Castings Co. No change has taken place in the management, ownership, or personnel.

West Coast Machinery Co., 1006 First Ave. S., Seattle, Wash., has been appointed representative of the Rockford Milling Machine Co. and the Rockford Tool Co. in the Seattle territory.

Triplex Machine Tool Corporation, 50 Church St., New York City, has appointed the Andrews & George Co., Tokio, Japan, exclusive sales agents for the Triplex combination bench lathe, milling, and drilling machine in Japan and Manchuria.

R. L. Barker & Co., 25 S. Clinton St., Chicago, Ill., has been appointed exclusive representative in Indiana, Illinois, Wisconsin, and Iowa for the Hisey-Wolf Machine Co., Cincinnati, Ohio, manufacturer of portable electric drills, screwdrivers, grinders, and buffers.

Pennsylvania Crusher Co., Philadelphia, Pa., has recently moved its Pittsburg office from the Peoples Bank Bldg. to larger quarters in the Oliver Bldg. to provide for their increasing volume of business in that district. H. M. Hallett will continue to serve as district manager.

Magnus Electric Co., Inc., Greenwich and Desbrosses Sts., New York City, manufacturer of electrical specialties, wiring devices, and radio accessories, has established a new district sales office at 231 N. Wells St., Chicago, Ill. Leo Hirschfeld and M. B. Geiger will be in charge of the new office.

Gits Bros. Mfg. Co., 1940 S. Kilbourne Ave., Chicago, Ill., manufacturer of lubricating devices and oil-cups, has just completed a large addition to its plant, and will now operate at more than double capacity. The company recently perfected a new line of cups and lubricating systems.

Oliver Machinery Co., Grand Rapids, Mich., has entered into an arrangement with the Canadian Fairbanks Morse Co., Ltd., whereby the latter company will represent the Oliver Machinery Co., exclusively throughout Canada, for the sale of its woodworking machinery and machine tools.

Dillon Electric Co., 1712 Eleventh St., N. E., Canton, Ohio, has just completed a two-story and basement addition to its Canton shop. The new building is 70 by 105 feet, of reinforced concrete construction, and when equipped with machinery, will double the capacity of the company's Canton plant.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., has moved its Cleveland office from Room 429 to Room 329 in the same building in which it has previously been located. The name of the building has been changed and in the future the address of the Cleveland office of the Link-Belt Co. will be 329 Rockefeller Bldg.

Hurlbut, Rogers Machinery Co., Nashua, N. H., manufacturer of cutting-off and centering machines, is now located in Nashua, N. H., its plant in South Sudbury, Mass., having recently been totally destroyed by fire. The larger facilities provided by the new quarters will enable the company to handle work to better advantage than previously.

Oilgear Co., 64 Twenty-seventh St., Milwaukee, Wis., has appointed the following companies sales representatives for its variable-speed hydraulic power transmissions: Federal Machinery Sales Co., 12 N. Jefferson St., Chicago, Ill.; Laughlin-Barney Machinery Co., Union Trust Bldg., Pittsburg, Pa.; and Elliott & Stephens Machinery Co., 721 Olive Ave., St. Louis, Mo.

American Emery Wheel Works, Providence, R. I., have just purchased a piece of property adjacent to their present plant, consisting of slightly over 34,000 square feet of land, and a substantial two-story brick building containing over 33,000 square feet of floor space. The acquisition of this property was made necessary by the increased demand for their product.

L. S. Starrett Co., Athol, Mass., referring to a prize contest recently conducted on "How Starrett Tools Have Helped Me Most in My Work," announces that toolmakers and machinists won 377 of the 474 prizes awarded. The four main prizes were won by Robert N. Walters, 824 Grand Ave., Racine, Wis.; Harry Gibler, DeBeque, Colo.; Leon H. Rice, 58 Riley Ave., Manchester, N. H.; and W. S. Clark, 430 N. Lawler Ave., Chicago, Ill.

Nielsen-Barton Chuck Co. has been reorganized under the name of the Nielsen-Barton Chuck & Tool Co., and has moved its plant from Chicago to Lawton, Mich. The officers of the reorganized concern are: President, C. W. Johnson; vice-president, H. E. Barton; secretary, Fred Lich; and treasurer, H. G. Nielsen. The new company has purchased six acres of land in the north part of Lawton, and has constructed a new brick factory, 50 by 100 feet.

Steelcraft Parts Co. has recently been incorporated with a capitalization of $100,000 to manufacture structural steel tools, including rivet sets, chisel blanks, pistons for riveting and chipping, hammers, chisel bushings, punches and dies, and hardened and ground bolts. The company will take over the plant of the Structural Tool Co. at 3160 W. 106th St., Cleveland, Ohio. The officers are: Charles L. Wasmer, president; Carl E. Kramer, vice-president; John L. Wasmer, secretary; and James J. Lally, treasurer.

Pelton Water Wheel Co., Inc., San Francisco, Cal., is planning to erect a two-story office and factory building, 150 by 200 feet, opposite its present building. The new building will house the office, drafting-room, pattern shop, pattern storage, and pump assembly departments. The present building will be devoted exclusively to the machine shop and turbine erection departments, the new arrangement enabling the present facilities to be virtually doubled. A number of additional machine tools will be installed.

Uehling Instrument Co., Paterson, N. J., manufacturer of carbon dioxide recorders and draft and vacuum gages, has appointed the Amsler-Morton Co., Fulton Bldg., Pittsburg, Pa, agent for its products in western Pennsylvania, and John A. MacDowell, 2039 Railway Exchange Bldg., St. Louis, Mo., agent for eastern Missouri and southern Illinois. H. R. N. Johnson who formerly represented the Uehling Instrument Co. in Minnesota and the Dakotas, has joined the W. P. Nevins Co., 120 S. Ninth St., Minneapolis, Minn., which is now the official Uehling representative in the territory mentioned.

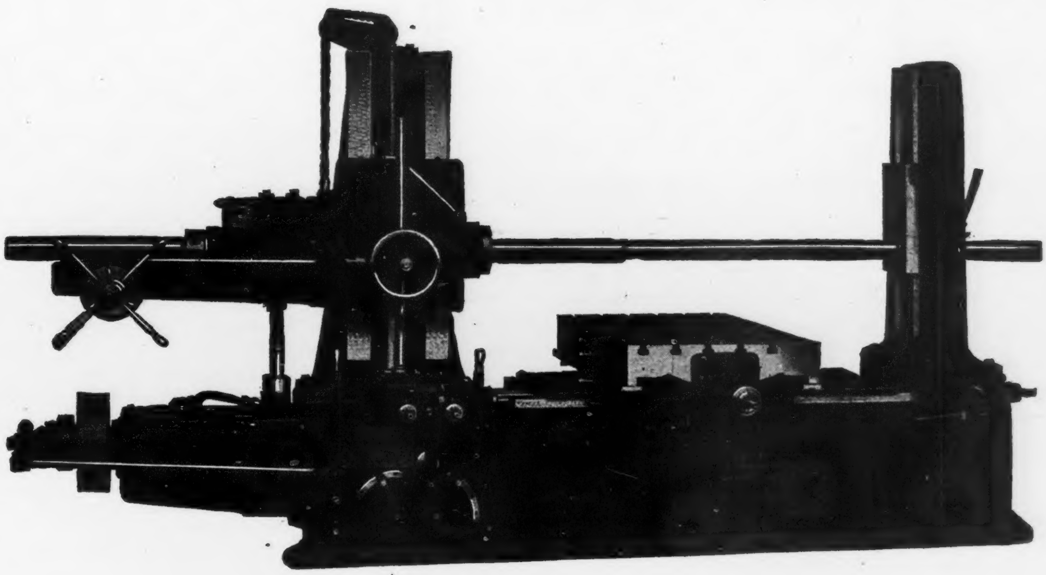
Henry Disston & Sons, Inc., Philadelphia, Pa., have opened a branch office at 130-132 Marietta St., Atlanta, Ga., in order to more adequately serve their customers in the southeastern states. In addition to the office, a showroom will be maintained at this branch, where samples of Disston products will be on display, including saws, files, machine knives of all kinds, and tool steel. A completely equipped repair department will also be maintained. E. F. Cooper has been placed in charge of the new branch. He has been associated with the company as a representative of the mill goods department for eight years.

B. F. Sturdevant Co., Hyde Park, Boston, Mass., has purchased the plant of the Wisconsin Engine Co. at Corliss, Wis. The plant covers nearly ten acres, and the buildings have approximately 150,000 feet of floor space. A full manufacturing and engineering staff will be maintained in this plant, and closer attention will thus be given to western customers. The new plant will be under the same direction as the other factories at Hyde Park, Galt, San Francisco, and Philadelphia. Harry W. Page has been selected as general manager in entire charge of the Wisconsin plant. For the last six years he has been assistant general manager and was located at the main office of the company at Hyde Park.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently acquired the plant of the Savage Arms Corporation, at Sharon, Pa. A large force of workmen is now engaged in remodeling and equipping the plant for the manufacture of transformers. The plant is expected to begin operations next fall. The transformer division now located at the East Pittsburg works will be transferred to Sharon, and 3000 persons will be employed in the new plant. C. H. Champlain, who has been assistant works manager at the East Pittsburg works, has been appointed works manager of the Sharon plant, and M. L. Fawcett, general foreman of the transformer department, has been made superintendent of the new works.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., announces the following changes in personnel: T. E. Simpers, formerly manager of the general mill section of the industrial department, has been appointed export representative of the industrial department. J. R. Olnhausen, manager of the textile section will have supervision over the industries formerly under the control of Mr. Simpers. C. H. Long, formerly manager of the contract section of the railway department, has been appointed a section manager of the light traction division, and is responsible for international negotiations and also for stocks and production schedules. R. W. Soady will succeed Mr. Long as manager of the contract section. W. P. Jend has been appointed manager of the merchandising division in the Detroit office, succeeding F. D. Koelbel who will take up general duties in connection with both the central station division and the merchandising division.

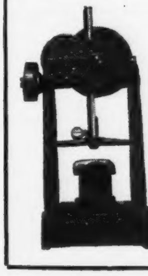
We Have Other Thoughts Than Gross Sales



"PRECISION"

Horizontal Boring, Drilling and Milling Machine

and we have a theory (which so far has worked to our satisfaction) that the more thought we give to making the best machinery we know how, and finding ways to make it better, the less thought we NEED give to anything else.



WE ALSO MAKE THE

LUCAS POWER

Forcing Press

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo. Aux Forges de Vulcain, Paris. Benson Bros., Sydney, Melbourne.

COMING EVENTS

August 20-30—Meeting of the American Institute of Mining and Metallurgical Engineers at Quebec, Canada. Secretary, F. F. Sharpless, 29 W. 39th St., New York City.

September 17-22—Ninth national exposition of chemical industries, in the Grand Central Palace, New York City. For further information address National Exposition of Chemical Industries, Grand Central Palace, New York.

September 24-28—Meeting of the Association of Iron and Steel Electrical Engineers at Buffalo, N. Y., in conjunction with the Iron and Steel Exposition held in the Buffalo Auditorium. Further information may be obtained from the Association of Iron and Steel Electrical Engineers, Empire Building, Pittsburg, Pa.

October 8-12—Annual convention of the American Society for Steel Treating to be held in Pittsburg, Pa., in connection with an international steel exposition. W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio, national secretary.

October 25-26—Production meeting of the Society of Automotive Engineers at Cleveland, Ohio. Further information may be obtained from the society's headquarters, 29 W. 39th St. New York City.

NEW BOOKS AND PAMPHLETS

Truck Operating Costs. By Ben H. Petty. 45 pages, 6 by 9 inches. Published by Purdue University, Lafayette, Ind., as Bulletin No. 10 of the Engineering Experiment Station.

An Investigation of the Fatigue of Metals. By H. F. Moore and T. M. Jasper. 100 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 136 of the Engineering Experiment Station.

Directive Radio Transmission on a Wave Length of Ten Meters. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 469 of the Bureau of Standards. Price, 10 cents.

Thermal Stresses in Steel Car Wheels. By George K. Burgess and G. Willard Quick. 403 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 235, of the Bureau of Standards. Price, 15 cents.

Practical Perspective. By Frank Richards and Fred H. Colvin. 69 pages, 4½ by 7 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $1.

This is the fourth enlarged edition of a book showing how to make all kinds of mechanical drawings in isometric perspective. It contains examples of various classes of work, as well as illustrations showing the use of isometric paper for lettering. A chapter by C. W. Reinhardt is also included dealing with the elementary principles of true perspective. This is intended as an elementary guide in making perspective drawings.

A Symbol of Safety. By Harry C. Brearley. 290 pages, 6 by 9 inches. Published by Doubleday, Page & Co., Garden City, N. Y.

In view of the fact that one of the most important problems of the present day is the promotion of safety in industry, the work of the Underwriters' Laboratories, Inc., 207 E. Ohio St., Chicago, Ill., described in this book, should be of considerable interest. Although originally instituted to meet the need of insurance companies for exact knowledge as to the many elements of hazard that must be taken into account in underwriting fire insurance, its activities have been greatly widened. The book contains an account of the various kinds of tests that are made and the different lines of investigation carried out by the laboratories on fire protection devices and other safety appliances. The work includes the testing of devices for fire prevention, electrical appliances, appliances for protecting life and limb, and safety devices for automobile and aircraft. This work is carried on in close cooperation with the manufacturers. The various standards that have been specified by the laboratories are included in the form of an appendix.

Essentials of Drafting. By Carl L. Svensen. 194 pages, 6 by 9 inches. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $1.75, net.

This is the second edition of a text book on drafting intended for use in connection with technical and vocational education. The revision has been based on changes that have been found advisable by the tests which have come from use by different teachers. Additions, rather than changes, constitute most of the work of revision. The chapter on orthographic projection has been made more complete, and the chapter on materials and stresses has been placed near the end of the book so that the continuity of the mechanical drawing study is not interrupted. The last chapter contains a collection of 240 problems to be worked out by the student.

Elements of Machine Design. By Dexter S. Kimball and John H. Barr. 446 pages, 6 by 9 inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, $4.

This book is the outgrowth of the experience of the authors in teaching machine design to engineering students in Sibley College, Cornell University. It is now in the second edition, and the revision has been based upon experience in the use of the book by various teachers in a large number of colleges. Certain changes in arrangement have been made, and a chapter on the fundamental principles of balancing has been added. The treatment presupposes a knowledge of mechanism and mechanics of engineering; however, a brief discussion of typical energy and force problems and of the more important straining actions is given, to make these important matters clear to the beginner. The largest part of the book is devoted to a discussion of the more important machine details, the purpose being to show how the theoretical considerations and equations discussed in the first part of the work are applied and modified in practice.

NEW CATALOGUES AND CIRCULARS

Biggs Boiler Works Co., Akron, Ohio. Catalogue of Biggs globe and cylinder rotary bleaching boilers for general paper mill service.

John Steptoe Co., Cincinnati, Ohio. Circular illustrating the Steptoe line of medium-priced shapers, milling machines, engine lathes, and die slotters.

Ingersoll Milling Machine Co., Rockford, Ill. Circular showing views in this company's factory and some of the equipment employed in building Ingersoll milling machines.

Pennsylvania Crusher Co., Philadelphia, Pa. Bulletin 1005, illustrating and describing the line of heavy-duty Pennsylvania "steel-built" hammer crushers made by this company.

United Machine & Mfg. Co., Canton, Ohio. Catalogue explaining the major features of the Harrington stoker, which is adapted for the successful burning of a wide range of fuels.

Nielsen-Barton Chuck & Tool Co., Lawton, Mich. Circular illustrating and describing the Nielsen-Barton drill chuck, which is adapted for use on drill presses, hand and breast drills, and post drills.

Byers Machine Co., 300 Sycamore St., Ravenna, Ohio. Catalogue showing applications of the Byers Model 3A auto crane for loading, unloading, and rehandling crushed stone, sand, gravel and other materials, and for use in industrial plants.

Jeannin Electric Co., Toledo, Ohio. Catalogue descriptive of the line of single-phase repulsion induction motors made by this concern. A list of the machines and devices which these motors are adapted for driving is given, and various applications of the motor are illustrated.

Wagner Electric Corporation, St. Louis, Mo. Bulletin 132, (vest-pocket size), covering the design, construction, and special features of the "Pow-R-full" motor. This company is also distributing a calendar for the year June, 1923, to May, 1924, arranged to show three months at a glance.

Cone Automatic Machine Co., Inc., Windsor, Vt. Leaflet illustrating and describing the features of construction of the Cone automatic four-spindle machine. A list of standard equipment furnished with the machine and standard attachments that can be obtained extra, as well as complete specifications, are included.

McCadden Machine Works, St. Cloud, Minn., are distributing a card advertising hardened cast-iron pistons which are hardened by a new medium known as "Macalene," a mixture which is added to ordinary quenching water or oil and is claimed to produce such a degree of hardness that the pistons cannot be touched with a file.

Erie Foundry Co., Erie, Pa. Bulletin 100, illustrating and describing Erie board drop-hammers, which are built in sizes of from 200 to 4000 pounds. Bulletin 110, descriptive of the Erie roller leveler for use in sheet mills and galvanizing plants for flattening sheet steel, and which is also adapted to the needs of operators of drawing presses.

Foxboro Co., Inc., Foxboro, Mass., manufacturer of indicating and recording instruments, is distributing a circular in the form of a blueprint containing directions for installing the Foxboro triplex draft gage on a B. & W. boiler furnace equipped with a chain grate stoker. This gage is equally applicable to other types of furnaces and stokers.

R. L. Barker & Co., 25 S. Clinton St., Chicago, Ill. Circular illustrating the line of electric tools, including grinders and buffers, lathes, heavy-duty drills and reamers, drilling stands, motor drills, etc., made by the Hisey-Wolf Machine Co., for whom R. L. Barker & Co. has recently been appointed exclusive representative in Indiana, Illinois, Wisconsin, and Iowa.

Campbell Auto Works, 238 N. El Dorado St., Stockton, Cal. Circular descriptive of the Campbell expansion cylinder reamer, which was developed to overcome some of the difficulties encountered in reboring automobiles or gasoline engine cylinders. Circular illustrating and describing Campbell bearing pullers and outer race extractors for removing bearings of electrical equipment.

Landis Machine Co., Waynesboro, Pa. Catalogue 26, covering the Landis line of bolt-threading die-heads and machines, as well as automatic screw cutting die-heads. The Landis die is described in detail, and an attaching chart and diagrams of clearance for the different sizes of die-heads are included. Complete specifications are given for the various sizes of threading machines. The book concludes with tables of standard threads, lag screws, and cutting speeds.

Bullard Machine Tool Co., Bridgeport, Conn. Bulletin descriptive of the Bullard 18-inch continuous chucking and turning machine, which was developed specifically for machining flywheels, but is also adapted to a wide variety of boring, turning, and facing operations on other work. In addition to giving complete specifications, this circular also shows tooling set-ups for machining Ford tractor flywheels, and illustrates by line drawings specimen work produced on this machine.

Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., manufacturer of the multi-graduated precision grinder, thread lead variators, lathe spacing attachments and "cold-set" diamond tools, has issued a new handbook and catalogue on thread grinding. This illustrates the use of the multi-graduated precision grinder for producing accurate ground threading tools, such as taps, dies, gages, hobs, chasers, etc. Engineering data relative to thread grinding is included. Copies will be sent upon request.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Supply catalogue, which is virtually an encyclopedia of electrical machinery and supplies, covering 1300 pages devoted to descriptive matter, technical data, drawings, specifications, and prices. The new catalogue includes all new apparatus that has been developed by this company in the last two years. The present edition is known as the 1923-1924 issue, and replaces all catalogues heretofore issued on electrical supplies by the company. The catalogue also announces the opening of a new plant at Homewood, Pa., which will be engaged exclusively in the manufacture of repairs and renewal parts for Westinghouse apparatus.

Rockford Milling Machine Co., Rockford, Ill. Circular containing illustrations and a detailed description of the Sundstrand double-end lathe, which has been built especially for such work as turning axle shafts, rear axle housings, camshafts, and similar parts that can be advantageously turned at both ends simultaneously. The machine is also adapted for turning short pieces, such as four-arm spiders, universal joint crosses, etc. Typical tooling lay-outs for different jobs are illustrated. Circular illustrating and describing the Rockford double-end drilling and centering machine, which is designed primarily for centering both ends of a shaft simultaneously, but which is also adapted for a wide range of work where it is desired to drill from opposite directions.

Chicago Belting Co., 127 N. Green St., Chicago, Ill., is issuing a series of circulars dealing with the subject of leather belting. One of the circulars discusses the subject of brands versus specifications in leather belting, and points out how both advantages are combined in Chicago pre-tested leather belts; another describes methods of identifying quality in leather belting, a third circular discusses the material used in Chicago belts; a fourth describes the testing and inspecting of leather belting at this company's plant; a fifth circular is entitled "The Only Way to Save Money on Belting Purchases"; and a sixth, entitled "Reflections of Character," contains recommendations from various users. A folder is included which gives the prices of leather belting made by this concern.

Gits Bros. Mfg. Co., 1940 S. Kilbourne Ave., Chicago, Ill. Catalogue illustrating lubricating devices and oil-cups suitable for practically all purposes in the lubrication of machinery of different types. The catalogue shows an inexpensive and highly developed oiling system for application to practically every form of bearing used in machinery, providing lubrication for an average period of one month with but one filling of the oil reservoir. A large assortment of self-closing oil-cups, oil-hole covers, and oil gages is also shown, and illustrations and description of the Gits wired wick system for positive lubrication are included. Sections of bearings are shown, indicating how positive lubricating devices can be applied to different types of bearings, including those employed in machine tools and countershafts.

Cleveland Worm & Gear Co., Cleveland, Ohio. Book entitled "Cleveland Worm Gear Reduction Units," containing a complete description of the worm drives designed and built by this company for a number of different purposes. Complete tables of the horsepower rating of these worm-gear reduction units are included, and information on the application of these drives is given. Special sections of the book deal with lubrication, lineshaft drives, formulas and data for calculating worm-gearing, and horsepower of shafting. A number of useful tables are given relating to gear calculations, including complete tables of pitch diameters for circular pitch gears; equivalent values of electrical, mechanical, and heat units; and useful factors in mechanical calculations. The book covers 101 pages, 8 by 10½ inches.